POWER PLANT ENGINEERING

Established Over 31 Years

VOL. XXXI CHICAGO, NOVEMBER 1, 1927 No. 21

Contents of this Issue

Page

Central Heating Plant Serves Mariemont. Illustrated....1124
High Pressure Piping Causes Little Trouble. Illustrated..1130
Red Cross in Restoration of Flood States.....1132
Throttling Suction Changes Pump Characteristic. By Blake R. Vanleer. Illustrated.....1133
Well-Type Furnace Tests at Huntley Station. By H. M. Cushing and R. P. Moore. Illustrated.....1135
Crawford Avenue Station Adds Two Units. Illustrated..1137
It Pays to Encourage Community Improvement. By Lester G. Herbert. Illustrated.....1139
Specifications Governing the Purchase of Coal. By Morgan B. Smith. Illustrated.....1141
Diesel Engine Maintenance. By W. Marx Kaufmann....1142
Calculating Short Circuit Current Values. By E. McCormack. Illustrated 1143
Care of Spare Parts for Electrical Equipment.....1146
Comments on Steam Trap Operation. Illustrated.....1147
A New Application of Receiver Separators. By C. E. Joos. Illustrated 1149
Steam Accumulator Smooths Boiler Load Peaks. Illustrated 1151
New Modern Ice Plant at Kansas City. By C. Camp. Illustrated 1152
Water Pumped to Reservoir Operates Hydro Plant. Illustrated 1155
A Hot Tale in Cold Cash. By John S. Carpenter. Illustrated 1156
Models Aid Design of Centrifugal Pumps. Illustrated....1156
Slagging Difficulties Being Reduced.....1157
Sandt's Eddy Cement Mill Makes Power from Waste Heat. Illustrated 1158
Efficiency Keynote of National Fuels Meeting.....1159
Letters Direct from the Plant: Piping Connections for Sampling Flue Gas. Designation of Pulverized Coal Sizes. Truss Forms Convenient Pipe Support. Kink Makes Key Removal a Simple Matter. Pipe Plug Forms Convenient Pressure Tester. Too Many Warnings. Illustrated 1161
Questions and Answers.....1164
Editorial Comment: Models Aid Engineering Design. Relay Settings on Distribution Networks. The High Cost of Fuel Saving. "Metropolis".....1166
New S-A Simplex Carrier. Illustrated.....1168
Webster Drip Trap Designed for Large Capacity. Illustrated 1168
Tornado Portable Electric Blower. Illustrated.....1169
Portable Watthour Meter Compensated for Temperature. Illustrated 1169
Coppus Ventilator for Hot Spots. Illustrated.....1170
"Quick-Lift" ¼-T. Hoist. Illustrated.....1170
75,000-Kw. Turbine for Buffalo General Electric Co......1170
Westinghouse to Supply Large Units for Hell Gate.....1170
Celluloid Model Checks Stevenson Creek Dam Tests. Illustrated 1171
All Contracts Let for St. Louis Municipal Plant.....1171
News Notes 1171
Catalog Notes 1174

Published on the 1st and 15th of each Month by the

Technical Publishing Co., 53 West Jackson Blvd., Chicago

New York Office, 150 Nassau Street

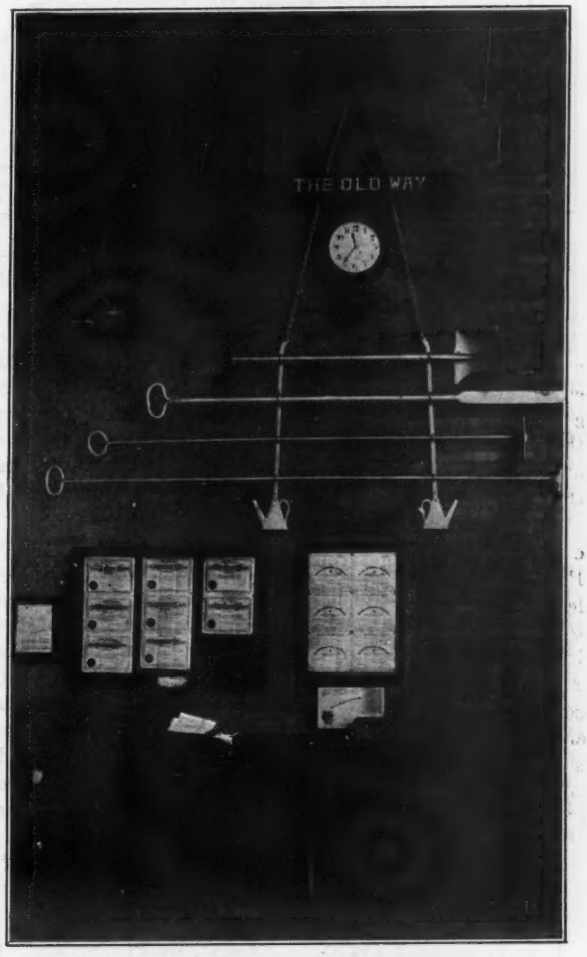
Subscription price $2.00 a year in the United States and possessions. Canada $2.75 a year. Other countries $3.50 a year. Single copies 15 cents.
Copyright 1927, by Technical Publishing Co.
Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Member, Associated Business Papers, Audit Bureau of Circulations.

Circulation of this Issue 22,900

EDITORIAL STAFF

ARTHUR L. RICE, Editor
R. E. TURNER, Managing Editor
A. W. KRAMER, Associate Editor
CHESTER R. EARLE, Associate Editor
RICHARD H. MORRIS, Associate Editor
EDWARD J. KUNZE, Associate Editor

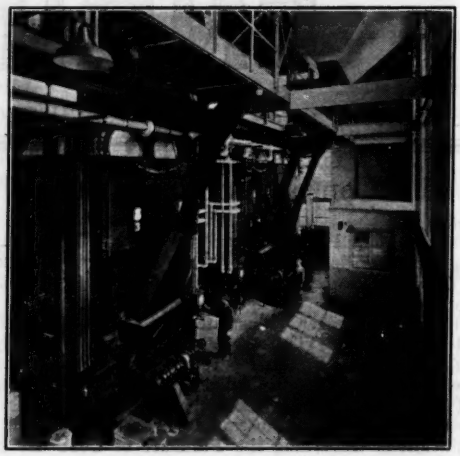


Stoker Firing on the Styx?

NOT A chance! Fuel and labor are both plentiful down that way and neither Charon nor Old Nick have felt the need of efficiency so they still use hand firing. Of course, we do not mean to insinuate that hand firing has no place on this earth but you can see by the above picture that it is in its eleventh hour, so far as large power plants are concerned. The Smoke Abatement League of St. Louis believes there is a devil in every coal pile and it is easy to believe that some of these little fellows attended the Fuel Conference reported on page 1159 and warned their Chief against taking a chance on admitting any of those combustion engineers to his popular resort for fear of dissension and continuous argument. Oh well! Who cares?

Central Heating Plant Serves Mariemont

ARRANGEMENT, EQUIPMENT AND MANAGEMENT OF MARIEMONT'S HEATING PLANT MANIFEST THE EFFORTS MADE TO PROVIDE FOR ABSOLUTE RELIABILITY OF SERVICE AND GUARD AGAINST RADIANT AND CONDUCTIVE HEAT LOSSES



MARIEMONT, OHIO, a fine example of community housing, is a suburb of Cincinnati and is governed under a plan prepared after suggestions by the Rockefeller Bureau of Municipal Research by an elected mayor and board of aldermen, through a city manager. It is fair to suppose that the central heating plant and heating system, which were installed by the Mariemont Co. for the purpose of supplying heat to the public buildings and houses in the major part of the town, would be of the best.

Located at the foot of a bluff at the southeasterly corner of the town site, adjoining the tracks of the Pennsylvania Railroad, as shown in Fig. 1, and at a level about 100 ft. below that of the main part of the town, the central heating plant is so placed that when it is deemed desirable, a return system may be installed. At present all condensate is wasted. The building is constructed of steel, concrete and brick, with the concrete foundations set on piles. Truscon steel glazed sash affords ample natural light, electricity purchased from the public service company being available for artificial lighting when desired.

High pressure steam is generated for heating purposes only as no provision was made in this plant to furnish electricity for light and power, using bleed steam turbines for the steam heating system, as is possible in plants of this kind. A franchise was awarded a local public service corporation to furnish electricity in the form of alternating current, single phase, 60 cycle, 110-220 v., carried on a 3-wire system, which is distributed through underground conduits just as all other services are distributed in Mariemont.

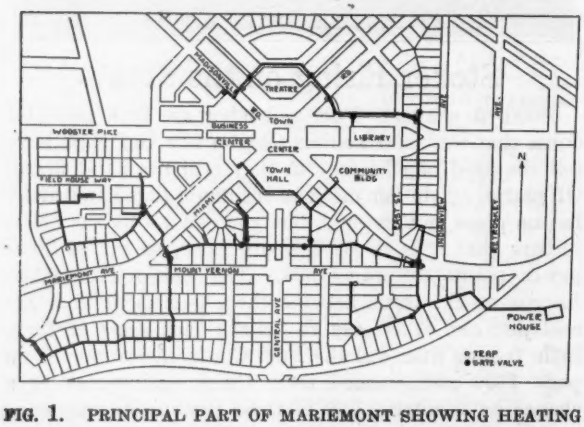


FIG. 1. PRINCIPAL PART OF MARIEMONT SHOWING HEATING SYSTEM LAYOUT AND ITS RELATION TO THE CENTRAL STATION

Boiler pressure is carried at 110 lb., which is reduced at the plant to 25 lb. by passing through reducing valves, after which it is throttled down, at the present time to from 5 to 2½ lb., in the service piping because of the light load carried. After normal load is established, the reducing valves alone will take care of such reduction in pressure as will be necessary.

Two 1¼-in. relief valves on the low pressure side of the 10-in. reducing valves are set at 50 lb. One 1¼-in. relief valve on the low pressure side of the 4-in. reducing valve is set at 7 lb.; and two 1¼-in. relief valves on the boiler feed pump discharge line are set at 135 lb.

Three 379-hp., two drum, three pass Heine water tube boilers with horizontal baffles and having 3794 sq. ft. heating surface have been installed. Two of these are set in one battery while provision for a fourth unit has been made to be set with the third boiler. These boilers were designed for 165 lb. pressure and are equipped with Reilly standard four retort underfeed stokers which are arranged to be driven either by a vertical steam engine or an electric motor. There are 92 sq. ft. of grate surface and the furnace volume is 1067 cu. ft. The lower part of the furnace is lined with Bernitz hollow blocks, the upper part being of fire brick. Sil-O-Cel brick is used on the outer walls of the settings. Expanded metal bands tie the fire brick through Sil-O-Cel brick to the red brick wall.

West Virginia bituminous nut and slack coal, having a heating value of 13,670 B.t.u. per lb., is used for fuel. Analysis of an average sample runs about as follows: Moisture, 1.70 per cent; volatile matter, 32.90 per cent; fixed carbon, 57.00 per cent; and ash, 8.40 per cent.

Coal from the cars is either dumped into a track

hopper or removed from the cars by 1½-yd. grab buckets and distributed in the coal storage yard of 800 t. capacity by means of a crane having a 60-ft. mast, shown at A in Fig. 2. When it is to be placed at once in the overhead bunker, it is dropped from the track hopper upon an apron feeder. Provision is made to warm the coal at the lowest point of the feeder by means of steam coils so as to avoid clogging up the system if the coal becomes frozen together during the winter months. From the apron feeder the coal is dumped into the dump. This feed automatically stops when the chute is full. Counters on each scale register the number of dumps made into the coal chute, thus accounting for the weight of coal used in each boiler.

Ash, passing over the dump plates of the stokers, drops through a steel ash hopper which is lined with fire brick, to ash cars, running on narrow gage tracks. Each ash hopper is provided with a 30 by 30-in. duplex clamshell ash valve and an ash scale is also installed. Provision is made for the removal of soot through a 6-in.

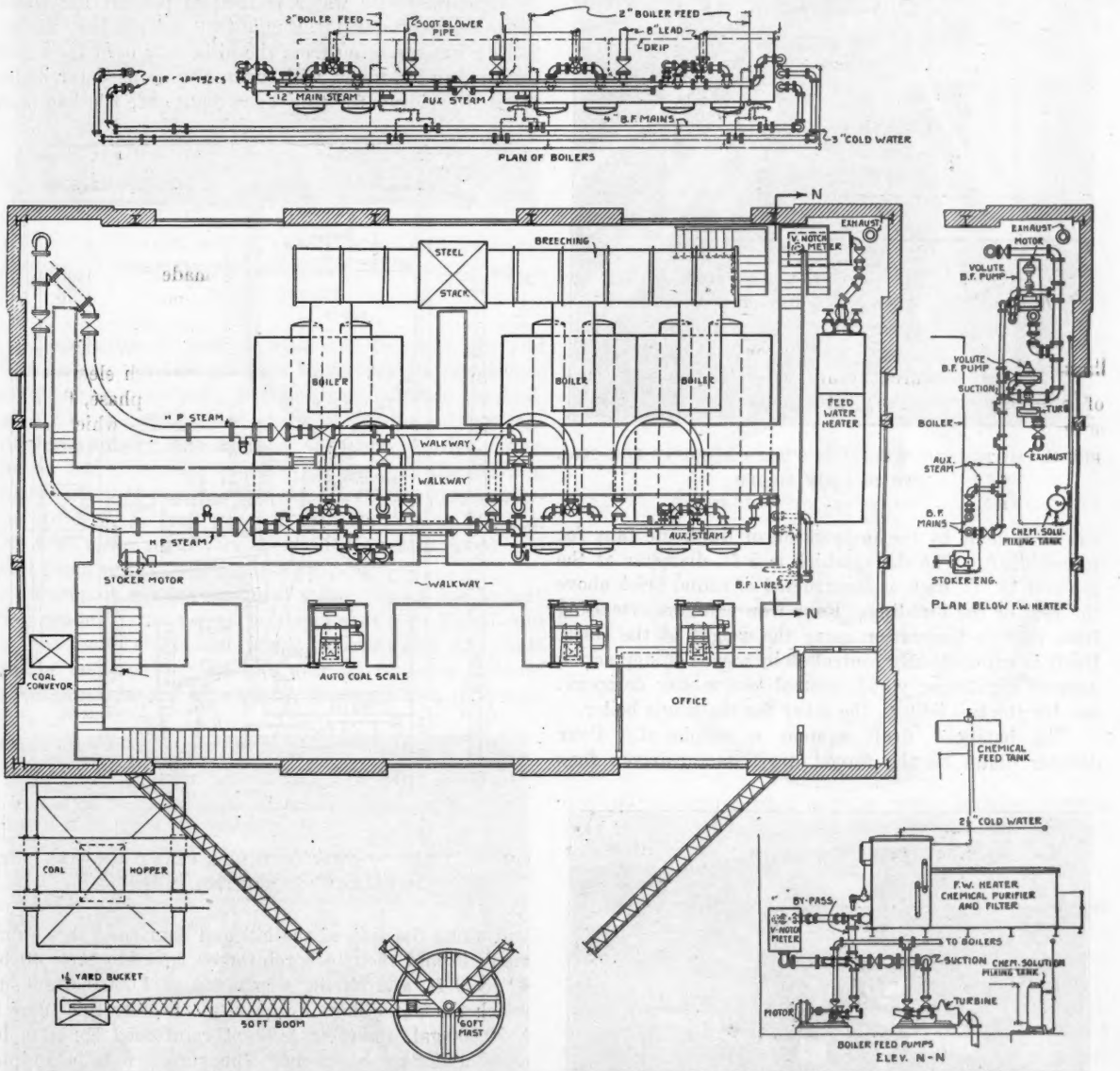


FIG. 2. PLAN OF BOILER ROOM SHOWING GENERAL ARRANGEMENT, ALSO FEED WATER HEATER AND BOILER FEED PUMP CONNECTIONS

crusher which has a capacity of 20 t. coal per hr. It then passes to a bucket conveyor which delivers to the overhead reinforced concrete bunker, whence it is distributed by drag buckets as desired. From the overhead bunker the coal drops by gravity to automatic weighing scales, the hoppers of which are balanced for 200 lb. An electric control at the stoker operates the coal scale motor, feeding 200 lb. of coal in the chute for each

diameter chute, into bags which are hung from the bottom of the soot chutes and production of dust and fumes is avoided by sprinklers located in the ash hopper just below the furnace floor. These sprinklers, which are in protected positions, are operated by hand from the basement floor. At the present time only from 6.6 to 9.3 t. coal are consumed per day.

Natural draft is employed at present but provision

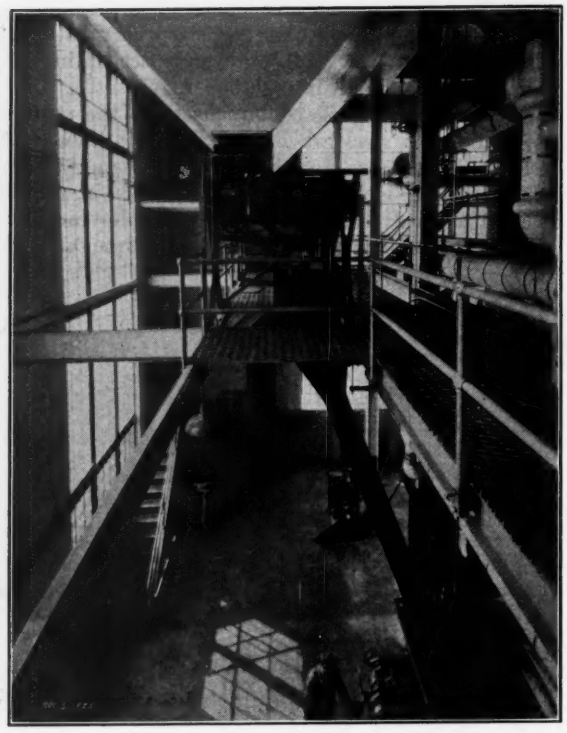


FIG. 3. AUTOMATIC WEIGHING SCALES ACCOUNT FOR COAL FED TO EACH BOILER

has been made by the installation of duplicate fans for forced draft. The stack, which is 5 ft. diameter at the top and 150 ft. high, is constructed of radial brick above the roof of the building. Four iron columns extending from roof to foundation carry the weight of the stack. Draft is automatically controlled by means of step action damper regulators, which control two master dampers; one for the two boilers, the other for the single boiler.

The balanced draft system is employed. Four damper plates on the forced draft, motor-driven fans

FIG. 4. ASH CONVENIENTLY REMOVED BY MEANS OF ASH DUMP CARS

are automatically controlled by Mason regulators which also control the speed of the steam turbine drive of the other fan. The sheet iron breeching is of 4 by 8 ft. cross section. The flue gases are discharged from the stack at about 360 deg. F. Soot blowers attached to each boiler are used every 8 hr. during operation of boiler and provision is made to drain off all condensation.

Water Supply and Treatment

Cincinnati city water is used at present for boiler feed, being supplied through two independent mains. Spring water coming from the hills, now used for street flushing and gardens, will eventually be used for boiler feed. Providing for this, open joint soft tile has been

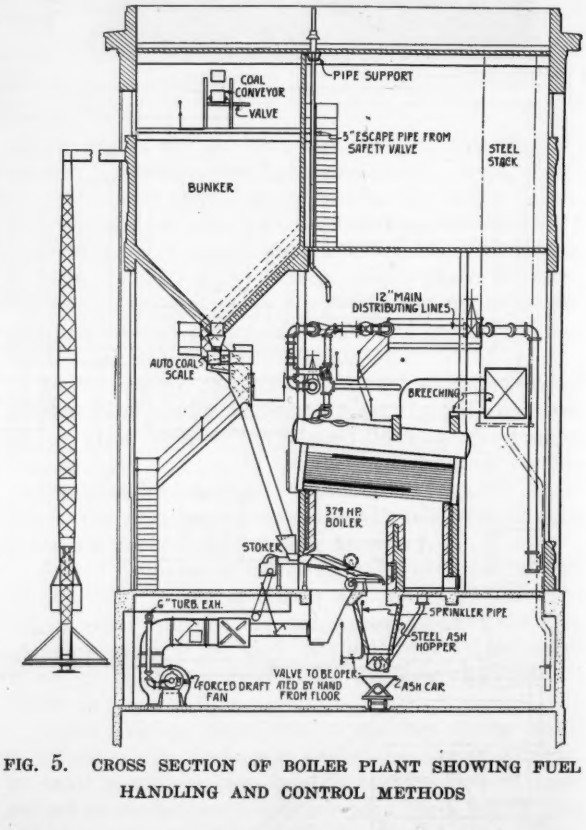


FIG. 5. CROSS SECTION OF BOILER PLANT SHOWING FUEL HANDLING AND CONTROL METHODS

laid along the side of the hill and connected to a sump manhole and then to a reinforced concrete tank 40 by 40 by 9 ft. and having a capacity of 1,080,000 gal., to which the water flows by gravity. Besides this there is a 20,000-gal. reservoir tank of reinforced concrete located under the basement. This supply is to be supplemented by driven wells 180 ft. deep which will be operated by means of axiflow deep well pumps.

Analysis of the Cincinnati water now used gives the following:

	Gr. per gal.
Calcium carbonate	2.72
Calcium sulphate	3.20
Magnesium sulphate	2.45
Iron oxide and alumina	0.17
Sodium and potassium sulphate	1.49
Suspended matter	0.34

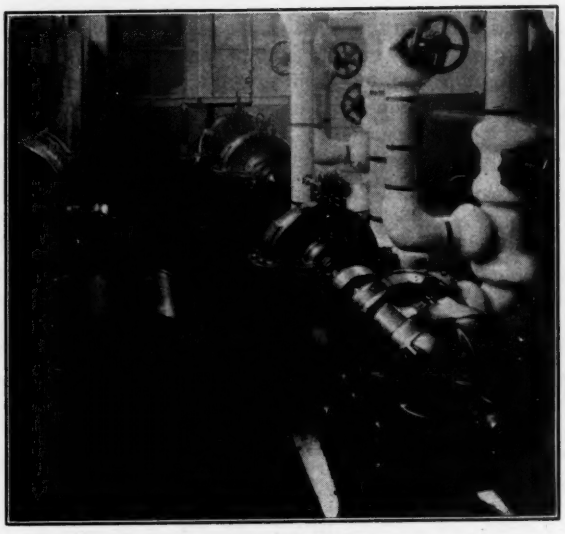


FIG. 6. DUPLICATE BOILER FEED PUMPS; ONE IN BACKGROUND IS TURBINE DRIVEN, THAT IN FOREGROUND IS MOTOR DRIVEN

This water is treated with 0.90 lb. soda ash and 0.54 lb. lime per 1000 gal. in a hot process water softener resulting in practically zero hardness entering the boilers. The water is tested every 24 hr. for calcium sulphate and daily for alkalinity and concentration. This heater has a capacity of 5000 gal. per hr., the limiting factor being the capacity of the filter. The rise in temperature of the feed water is from 48 deg. to 210 deg. No feed water regulators are used at present, hand control being relied upon for this purpose.

Provision for expansion of steam piping due to heat was made by the use of bends as shown in Fig. 7 and by the use of single and double variators and slip joints in the heating lines, no run over 60 ft. being without some provision for expansion. Wrought iron pipe with welded joints is used and all steam piping in the plant is covered with 85 per cent magnesia while hair felt is used to cover cold water pipes, a color scheme being used to identify the various pipes. Figure 8 shows an isometric line diagram of the pipe connections and Fig. 9 the method used for providing for expansion in the small steam pipes that are enclosed in large cast-iron pipe.

FIG. 7. PIPING OVER BOILERS, SHOWING PRECAUTIONS TAKEN TO PROVIDE FOR EXPANSION

Heating Plant Management

Besides a master gage, a complete set of both indicating and recording gages covering all lines is located in the engineer's office. A daily log sheet, Fig. 10, filled out by the firemen, is also submitted and complete records kept.

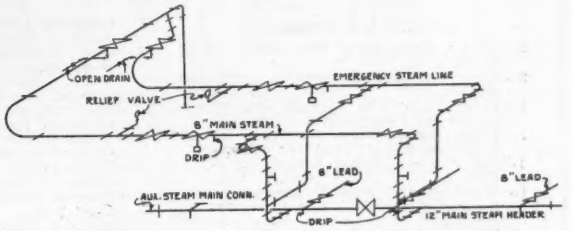


FIG. 8. LINE DIAGRAM OF PIPING, SHOWING FITTINGS AND CONNECTIONS

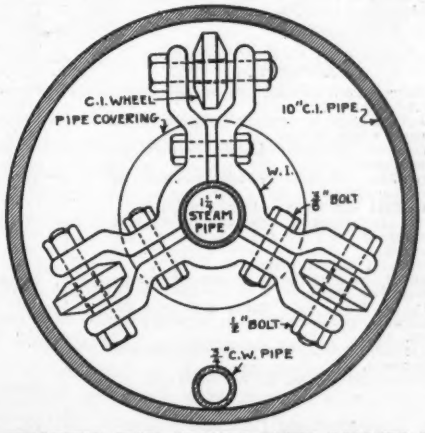


FIG. 9. WROUGHT IRON CLAMPS WITH ROLLERS PROVIDE SIMPLE MEANS FOR TAKING CARE OF EXPANSION OF SMALL PIPE

Two panels of marine finish slate 1 in. thick are provided for the switchboard; one for the lighting load, the other for power, each being enclosed in a steel cabinet.

Fire protection is provided for by means of a hand-controlled sprinkler system which is operated every 4 hr. Piping in the coal bunkers provides sprinklers under the coal and an auxiliary 2-in. fire hose is also provided.

Heat Distributing System

Atmospheric or vapor type heating is used. Steam delivered at the low pressure of 2 lb. at entrance to buildings is easily maintained at that pressure due to the ample sizes of the mains installed. Increased demand can readily be supplied by increasing the pressure in the mains which is done by regulating the reducing valves controlled at the central heating station.

Drainage conditions being very favorable and sandy loam prevalent, wood casing—a combination conduit and insulation—was used in the construction of the distributing steam mains and service lines. This type of line was chosen because of its low cost, easy installation and, under prevailing conditions, its low heat loss by conductivity.

Standard weight wrought iron pipe was used in all underground work; all valves and expansion devices are of cast iron and annealed corrugated copper gaskets are used between all flanges; all other joints were oxy-

around and into the wood under high tension, as shown in Fig. 9. The outside is waterproofed in asphaltum pitch and rolled in sifted sawdust to prevent sticking together in handling. One inch of air space surrounds the enclosed pipe. Three thicknesses of asbestos paper are held in place inside of this wood casing by a lining of high grade sheet tin. This bright surface reflects the heat rays, thus preventing absorption and consequent loss of heat. The asbestos paper and air spaces between the tin and casing protect the casing against slow deterioration by charring.

Principal Equipment in Mariemont Heating Plant

Boilers and Stokers

3—379-hp. Heine water tube boilers—3794 sq. ft. h. s.
3—Riley standard four-retort underfeed stokers.
1—15-hp., 7 by 6-in. vertical Troy steam engine for stoker drive.
1—15-hp. Westinghouse compound wound induction motor for stoker drive.
2—Bayer soot blowers, complete. Type (H) 1.
1—Westinghouse type F magnetic controller on starting box of stoker motor, controlled by type C.A. push buttons.
Furnace lining—Bernitz hollow block.
Brickwork for settings constructed by McCabe Construction Co.
Fire brick by Portland Stoneware Co.
Plastic covering for outside of setting, 2 coats of Celcote—Celite Products Co., each coat being ⅛ in. thick.

Coal and Ash Handling Apparatus

1—Jeffrey 20-t. per hr. crusher.
3—Richardson scales.
1—Jeffrey hoist equipment including track hopper and dump.
2—General Electric 15-hp. motors for crushers.
2—General Electric 15-hp. motors for conveyors.
1—Buffalo ash scale, capacity 6000 lb.
2—General Electric overload reset type starting boxes for conveyor and crusher.
3—General Electric type C R 1038 A I electrical controls at stoker for operating coal scales.
2—C. W. Hunt side dump ash cars for narrow gage (21½ in), capacity 27 cu. ft.
3—Littleford Bros. coal spreaders on coal hoppers.
Industrial tracks, C. W. Hunt Co.

Pumps and Heaters

1—Westinghouse 30-hp. steam turbine driven Worthington centrifugal volute type boiler feed pump. Speed 1800 r.p.m.; capacity 300 gal. per min.
1—Westinghouse 30-hp. motor driven Worthington centrifugal volute type boiler feed pump. Speed 1750 r.p.m.; capacity 300 gal. per min.
1—Cochrane hot water heater. Capacity 5000 gal. per hr.
1—5-hp. Westinghouse steam turbine driven Worthington type 2 CL-OS auxiliary pump. Speed 1800 r.p.m.; capacity 150 gal. per min.
1—5-hp. Westinghouse motor driven Worthington type 2-CL-OS auxiliary pump. Speed 1750 r.p.m.; capacity 150 gal. per min.
1—Westinghouse type A automatic starter on boiler feed pump motor.
1—Westinghouse type A automatic starter on service pump.
1—Worthington Axiflo type deep well pump. Capacity 75 gal. per min.
1—General Electric 5-hp. motor for deep well pump, with General Electric starting compensator.

Fans and Draft Equipment

1—50-hp. Moore turbine driven Sturtevant fan. Size 80, design 4.
1—50-hp. General Electric motor driven Sturtevant fan. Size 80, design 4.
2—Littleford Bros. vertical shaft master dampers.
4—Damper plates on fans.
3—Horizontal shaft uptake dampers.
1—Mason regulator for controlling damper plates and steam turbines on fan.
1—Ruggles-Klingemann step action regulator on master dampers.
3—Engineer Co. balanced draft regulators on uptake dampers.
1—Cochrane chemical mixer. Treatment capacity 5000 gal. per hr.
1—Lime and soda ash treatment apparatus using about 15 lb. soda and 4 lb. lime per 24 hr. on present light load.
1—3-hp. Fairbanks-Morse motor driven impeller type circulating and chemical pump for water softener. Speed 1800 r.p.m. Capacity 50 gal. per min.
1—Roto Co. water driven tube cleaner.
Stack—Heine Chimney Co. Height 150 ft.; diameter 5 ft.

Meters and Gages

3—Bailey boiler meters—steam and air flow and flue gas temperature.
3—Lewis M. Ellison draft gages.
1—Republic Flow Meters Co. CO_2 recording meter.
1—V-notch, Cochrane integrating, indicating and recording type flow meter on heater.
1—Foxboro Co. recording gage for water temperature at heater.
3—Ashton 12-in. steam gages.
5—Indicating and 4 recording pressure gages—American Schaeffer & Budenberg Co.
1—Bristol electrically operated recording gage for terminal pressure.

Valves

1—Chapman 12-in. lever weight relief valve.
15—Cadman blowoff valves, 5 on each boiler.
17—Lunkenheimer check valves.
10—Lunkenheimer stop valves.
6—3½-in. Ashton spring loaded safety valves.
3—Lunkenheimer non-return stop valves.
2—Ruggles-Klingemann 10-in. spring loaded reducing valves for steam heating lines.
1—Ruggles-Klingemann 4-in. weighted lever reducing valve. Service: make up steam to feed water heater.
1—Mueller Co. 3-in. reducing valve. Service: water to feed water heater.
1—Mueller Co. 2-in. reducing valve. Service: house water.
2—1¼-in. Crane relief valves on low pressure side of 10-in. reducing valves. Set at 50 lb.
1—1¼-in. Crane relief valve on low pressure side of 4-in. reducing valve. Set at 7 lb.
2—1¼-in. Crane relief valves in boiler feed pump discharge line. Set at 135 lb.
Lunkenheimer high pressure valves.
Powell high pressure valves.

Piping and Fittings

1—No. 2 Anderson trap for 50-lb. steam.
4—No. 3 Anderson traps for 150 lb. steam.
1—No. 4 Anderson trap for 50 lb. steam.
1—No. 5 Anderson trap for 50 lb. steam.
Piping furnished by A. M. Byers Co. and Reading Iron Co.
Piping installed by John W. Danforth.
Pipe covering: 85 per cent magnesia on steam pipes; hair felt on cold water pipes by Johns-Manville Corp.
Variators, slip joints and anchor special fittings by American District Steam Co.

Miscellaneous Equipment

1—10-in. Swartwout cast-iron exhaust head.
1—3½-in Cochrane oil separator.
Trumbull type A safety electric switches.
General Electric flush tumbler type knife electric switches.
Sprinkler system piping in bunkers supplied with four sprinkler heads.
Auxiliary 2-in. fire hose controlled by hand.

acetylene welded. The steam supply is drip-drained and regulated just within the heating plant wall, 3 ft. above the second floor level, and passes into the 12-in. main line at a point well above the ground outside. Reenforced concrete pillars 20 ft. high and 16 ft. between centers support a specially constructed aerial housing for this elevated main for a distance of about 150 ft., where it then goes underground for an average depth of 5 ft. through the remainder of the system.

Protection to mains is afforded by means of wood casing which is 4 in. thick and formed of clear kiln-dried white pine timber made up in segments bound together by $\frac{3}{16}$-in. galvanized steel wire spirally wound

In installing the piping, after grading the trenches and filling them with 9 in. of crushed stone as shown in Fig. 11, the piping was lowered on roller blocks for welding in sections. After each section was welded it was tested at 100 lb. hydraulic pressure, then the pipe received a rust-proof covering of high grade protective varnish. The wood conduit was then drawn on each section and lengths joined by driving mortised and tenoned ends of casing together. These joints were waterproofed by an application of hot pitch, covered with strips of three-ply roofing and the whole further covered over for the upper three-fourths of its diameter with heavy roofing throughout its whole length to pre-

vent contact of ground moisture or seepage to conduit. More washed gravel was then placed in the space between conduit and sides of trench up to the covering or roofing, thus forming a complete porous mass at lower sides in conjunction with the previously placed crushed stone foundation and underdrain.

Through roadways and parkings where service was not required, special underground slip type expansion joints in roomy manholes were installed. Where many service lines branch off, packingless automatic expansion variators were installed, alternating with anchor specials. At 50-ft. intervals these latter fittings were provided with service nipples which extend outside of the brick work surrounding the fittings. Expansion joints and specials in manholes were anchored in concrete at their bases and variators and anchor specials were anchored at their sides.

Control valves were set in at junction points in the mains and automatic traps were provided at low points. The flow from these traps and from the tile lines in the under drainage system is discharged through connections to the storm water sewers. Practically no direct

Mariemont Central Heating Station

COAL			ASHES			TEMPERATURE
Reading	Lbs. Burned		Gross	Tare	Net	Outside
		1st. Watch				
		2nd. Watch				
		3rd. Watch				
Tons		Total	Lbs.			
FEEDWATER METER			STEAM			WEATHER
Reading	Lbs. Used		Reading		Lbs. Made	Conditions
		1st. Watch				
		2nd Watch				
		3rd. Watch				
Lbs.		Total	Lbs.			
STOKERS						Service Water Tank
Engine Drive			Motor Drive			Elevation
on M to M		1st. Watch	on M to M			Ft.
on M to M		2nd Watch	on M to M			Ft.
on M to M		3rd. Watch	on M to M			Ft.
BOILER FEED PUMPS						BOILERS
Turbine Drive			Motor Drive			Boilers on Line
on M to M		1st. Watch	on M to M			Nos.
on M to M		2nd Watch	on M to M			Nos.
on M to M		3rd. Watch	on M to M			Nos.
DRAFT FANS						SAFETY VALVES
Turbine Drive			Motor Drive			Tried
on M to M		1st. Watch	on M to M			M
on M to M		2nd. Watch	on M to M			M
on M to M		3rd Watch	on M to M			M
WELL PUMP			TUBES BLOWN			BLOWOFF VALVES
on M to M		1st. Watch		M		M
on M to M		2nd. Watch		M		M
on M to M		3rd. Watch		M		M
			ELECTRICITY			
Oil			Power			Light
Turbine	Trans.	Cylinder	Reading	K. W. H. Used	Reading	K. W. H. Used
		1st. Watch				
		2nd. Watch				
		3rd. Watch				
		Total				
Date			Signed			

FIG. 10. LOG SHEET WHICH IS FILLED OUT BY FIREMEN

contact exists between the steam conveying pipe line and the conductive substance, consequently heat losses through direct conduction are slight.

Further prevention of heat loss was secured by covering the valves and fittings in manholes with block magnesia and the upper half of the brick boxes enclosing buried variators and anchor specials, with magnesia-asbestos fiber. This blocked off the one-inch air space surrounding the pipe, at ends of encased sections, thus preventing circulation of air.

For the aerial portion of mains, supported on pillars from the power house walls to the hillside, full casing construction laid in a heavy timbered waterproof foundation trough, formed the principal construction. This line was further protected by sealed air spaces formed by alternate strips of soft wood edging and roofing paper around and over the casing and joined on the lower sides to the foundation trough. The outer protective covering was made of heavy galvanized sheet steel, enclosing full top and sides. All seams were soldered and the whole painted.

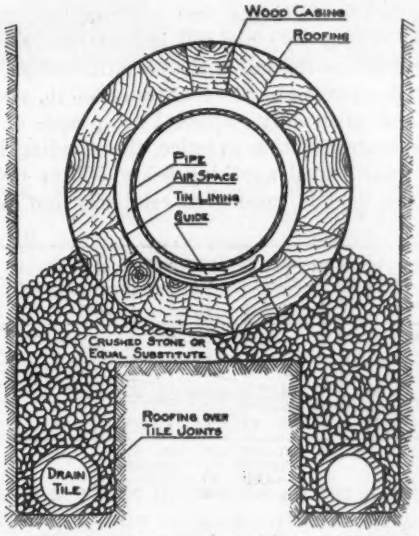


FIG. 11. UNDERGROUND STEAM MAIN, SHOWING METHOD OF SETTING AND PROTECTING PIPE

The steam heat distributing system was installed by the American District Steam Co. Fay, Spofford & Thorndike were the consulting engineers and Hollis French & Allen Hubbard associate engineers.

Steam Consumption of Soot Blowers

DATA COLLECTED by the N. E. L. A. shows that steam used for soot blowing in stations using natural gas is about 0.0002 per cent of the total steam generated. On pulverized fuel fired boilers ranging in size from 11,000 to 30,000 sq. ft. the average is 0.5 per cent with a minimum figure of 0.4 per cent and a maximum of 0.8 per cent. For stoker fired boilers ranging from 12,000 to 23,000 sq. ft., 0.2 per cent of the total steam is used while for stoker fired boilers ranging from 6000 to 7000 sq. ft., the quantity is increased to 0.6 per cent of the total.

Although it is impossible to state definitely the cause of this marked difference in stoker fired installations, it may be due to the fact that small boilers are relatively older and operated under a poor load factor, resulting in the steam for soot blowing being a greater percentage of the total being generated. The soot blowing equipment on these units probably also has a considerable effect.

Data submitted indicates that the soot blowers are operated two or three times as often on the pulverized fuel installations as with stoker fired installations, which also helps to account for the higher figure in the pulverized fired boilers.

IT IS BETTER to do your thinking before you make a decision than after.

High Pressure Piping Causes Little Trouble

DIFFICULTIES OF DESIGN AND SPECIFICATIONS MET WITH BY THE PIONEER COMPANIES ARE NOW CLEARED UP AND THE PROBLEM IS LARGELY A MATTER OF MATERIAL SELECTION AND MANUFACTURE, AS DESIGN PROBLEMS DIFFER LITTLE FROM THOSE ENCOUNTERED WITH LOWER PRESSURES

WITH THE STEADY upward trend of operating steam pressures during recent years there is no longer a definite dividing line between low and high pressures. About 3 yr. ago this imaginary dividing line was placed at 350 lb., but with the introduction of 1200 and 1400-lb. systems in this country, 3300 lb. systems in Europe and practically universal acceptance of 600 lb. for large central station practice, the dividing line has moved upward until anything below 550 or 600 lb. in the utilities field is considered relatively low pressure.

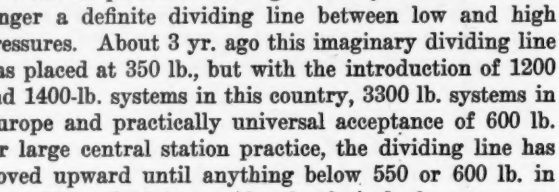


FIG. 1. WALL THICKNESS OF HIGH PRESSURE PIPING CALCULATED FROM THE MODIFIED BARLOW FORMULA

In the industrial field one 850 and two 1200-lb. installations have been made, but as yet 350 lb. and over can probably be considered in the high pressure field. Of course this assumes the maximum total temperature of 700 to 750 deg., which is practically universal in a modern power plant of any size, regardless of the general classification.

Completion of standards or tentative standards and specifications by the A. E. S. C., A. S. T. M. and

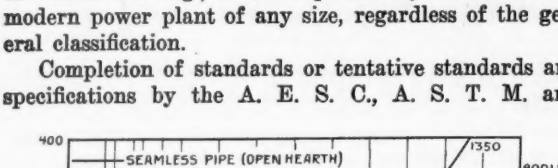


FIG. 2. WEIGHT PER LINEAL FOOT OF PLAIN END PIPING FOR 250, 400, 600, 900 AND 1350 LB. PRESSURES AS GIVEN IN THE A. E. S. C. AND A. S. T. M. SPECIFICATIONS

N. E. L. A. for high pressure piping, pipe flanges and flange fittings have eliminated many of the difficulties confronting the pioneers in this field.

Fundamentally the problem of design and layout is the same as for a 300-lb. station with the exception of the thicker, heavier and stiffer pipe which must be considered. From the first the problem was one of metals and fittings.

Development of cast and forged steel fittings and several special flange joints, either ground joints or joints designed for use with gaskets, has solved this problem more or less satisfactorily, although there is still considerable discussion regarding these items among both manufacturers and operators.

Piping itself has given little trouble. In the A. E. S. C. specifications for 250, 400, 600, 900 and 1350-lb. standard, sizes 1.5 in. and below are to be seamless pipe. For 2 in. and over, either seamless or lap welded pipe may be used for the 250 and 400-lb. series but seamless tubing is specified for all pressures in excess of these. Lap welded pipe must be of open hearth steel, but the seamless piping may be made either from low or medium carbon open hearth or electric furnace steel. For cold bending or welding the low carbon steel should be specified.

Wall thickness as plotted in Fig. 1 can be calculated from the modified Barlow formula as used in the A. S. M. E. boiler construction code. With the fiber stress taken as 7000 lb. per sq. in., this may be stated as $t = [(PD + 125) \div 14{,}000] + 0.065$ for nominal diameters of from ¼ to 5 in. For pipes of nominal diameters of over 5 in. $t = (PD \div 14{,}000) + 0.1$ where t = wall thickness of pipe in inches, P = working pressure in lb. per sq. in. and D = actual outside pipe diameter in inches.

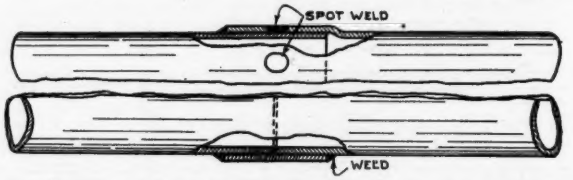


FIG. 3. TWO TYPES OF WELDED JOINTS IN USE ON HIGH PRESSURE STEAM LINES

Values of t plotted in Fig. 1 have been increased 12.5 per cent over the calculated value to allow for mill tolerance. Specifications state that for 1½ in. and smaller piping the outside diameter must not be more than $\frac{1}{16}$ in. over or $\frac{1}{32}$ in. under the specified diameters.

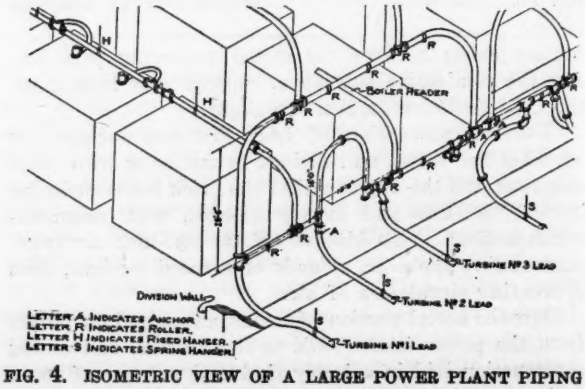


FIG. 4. ISOMETRIC VIEW OF A LARGE POWER PLANT PIPING SYSTEM SHOWING LOCATION OF ANCHORS AND SUPPORTS

For 2 in. and over the variation must not exceed 1 per cent.

Weights of the various sizes as taken from the A. E. S. C. specifications, are plotted in Fig. 2. For the 1350-lb. series the actual weight must not exceed these values by 10 per cent, while for pressures below 1350 the variation must not exceed 5 per cent. Each length of pipe must be marked to show the manufacturer, year made and working steam pressures. Other items dealing with the testing, inspection, physical and chemical properties are covered in some detail in the specifications. Hydraulic tests of 750, 1000, 1500, 2000 and 3000 lb. pressure respectively for 250, 400, 600, 900 and 1350 lb. series must be given to each piece of pipe at the mill. Welded pipe shall, furthermore, be struck near each end with a 2-lb. hammer while under pressure.

Welded Pipe Is Being Used for Pressures Up to 400 Lb.

Welded pipe is being used rather extensively for pressures up to and including 400 lb. working pressure in industrial plants, especially for long pipe lines. Figure 3 shows two methods which have been extensively used for making welded joints. The first is a patented joint, the price of the weld, exclusive of piping, ranges from $42 for 2½-in. pipe to $195 for 24-in. pipe. It is spot welded around the circumference and welded solid on the outside lap. The lower type joint is first welded in the center, after which a collar is shrunk on the outside and a weld made on each side of the collar.

By far the larger portion of the expense for piping installations lies in the valves and fittings. One manufacturer from data on many installations gives the following as a representative distribution of cost on a piping installation totalling about $26,000. Pipe 10 per cent; valves, fittings, flanges, hangers, bolts, gaskets, 66 per cent; shop work, erection and supervision, 17 per cent; pipe covering 10 per cent; freight, overhead, profit and miscellaneous, 7 per cent.

From the standpoint of the designer, the pipe layout and location and the design of anchors, hangers and expansion joints is the most important problem. Figure 4 is an isometric view of a modern station, showing

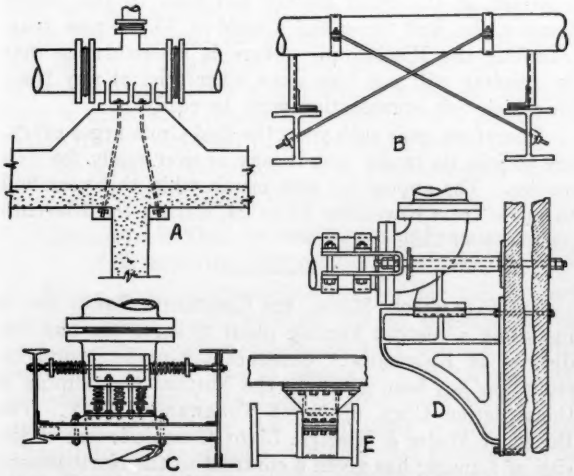


FIG. 5. SEVERAL ANCHOR DESIGNS WHICH HAVE BEEN DEVELOPED AND USED IN DIFFERENT PLANTS

FIG. 6. TWO DIFFERENT TYPES OF ANCHORS ILLUSTRATING INDOOR AND OUTDOOR PRACTICE

the piping layout, the location of anchors and hangers. Naturally the stress on the turbine being limited to a very small value, it is necessary to anchor the piping system near the throttle and throw the expansion through other parts of the system. Several anchors which have been developed and are in actual use are illustrated in Fig. 5.

Anchors May Be of the Rigid or Spring Type

Three types of rigid anchors are illustrated in Fig. 5A, 5B and 5E, the first and third requiring more or less special castings, made to order, but the second one, Fig. 5B, being practically a field design which has been found very satisfactory, especially for industrial service. Sometimes it is desirable to allow some leeway in the pipe movement. This can be accomplished by a limited travel anchor, as shown in 5D, or by the spring type anchor of 5C.

In Fig. 6 two additional anchor designs are shown. The first is on a 12-in. outdoor welded line 4500 ft. long, and is shown before the insulation was applied. The second is a special cast steel manifold with an anchor base and is of the same general type as that shown in Fig. 5A.

If the design permits, a base elbow near the throttle of the turbine is a satisfactory method of handling the anchor problem. Anchors in other parts of the system may or may not be necessary depending upon the layout and expansion facilities provided. Pipe should be cut short by half the calculated amount of expansion and drawn together when cold so as to reduce the distortion of the system at the two temperature extremes to a minimum.

Roller supports, such as illustrated in Fig. 7 are made in a variety of types and are very satisfactory

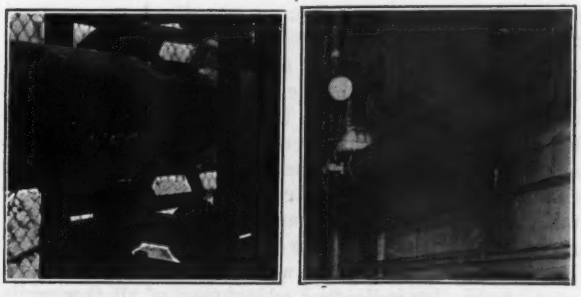


FIG. 7. ROLLER TYPE SUPPORTS WITH AND WITHOUT INSTALLATION GUARDS

when supports can be provided underneath. The one on the left is designed with insulation shields to protect the insulation. Curvature of the roller must be designed for the pipe diameter with the insulation in place. As a rule a roller is provided only on the bottom. The top roller in this case is designed to act as a guide for the pipe.

Spring hangers, such as shown in Fig. 8A and 8E can be made in a variety of forms, or the springs can be left out, making a more or less flexible support as shown in Fig. 8D. Turnbuckles should always be provided in hangers of this kind which, as a rule are

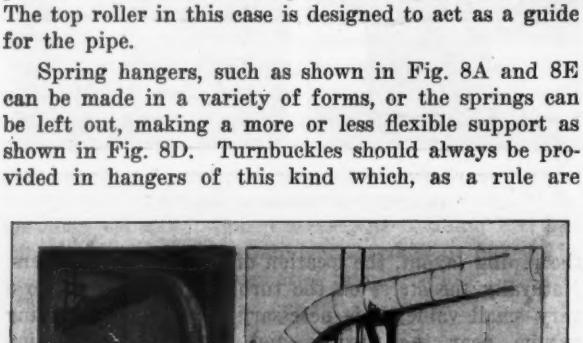


FIG. 8. VARIOUS TYPES OF PIPE HANGERS AND SUPPORTS USED IN MODERN POWER PLANTS

satisfactory, offer a cheap convenient type of construction and give the required flexibility to the system. When they are used to any great extent, however, provision to eliminate vibration must be made.

CONTINUOUS CIRCULATING of oil through bearings in certain types of heavy equipment affords a practical and economical way of automatically lubricating parts with a minimum of labor or attention. As a rule a considerably greater volume of oil will be involved in the circulating system than in a mechanical forced feed lubricator as a typical circulating system will involve a suitable oil reservoir in the base of a machine, a pump for transmission of oil either to an overhead auxiliary tank or directly to the bearings to be served and the necessary distributing pipes through each of the latter. Each line should be fitted with a feed device and adequate means for individual adjustment of all flow while means should also be provided for drainage or transmission of the used oil back to the base reservoir.

Red Cross in Restoration of Flood States

THROUGHOUT the past summer, the American Red Cross has been at work in the Mississippi River Valley, repairing insofar as it can, the human ravages of the nation's greatest peace-time disaster, the flood of last spring and early summer.

This flood affected a total of eight states, including Oklahoma, which state was not at first included among the strictly flood sections but later was considered as part of the general rehabilitation problem left by this disaster. All told, the Red Cross cared for an army of calamity-struck people which ultimately reached a total of more than 600,000, of which number 330,000 were driven from their homes into Red Cross emergency camps, the remainder of the number assisted being cared for outside of camps. Some remained in upper stories of homes or other temporary refuge places, and were fed and doctored and watched over by the Red Cross until the water subsided.

Despite the vast number who did not actually have to abandon their homes, the Red Cross established altogether a total of 149 concentration centers in which the homeless were sheltered, fed, doctored, and otherwise cared for until they could return.

All during the summer these unfortunates were returning homeward, or endeavoring to make a new start with their crops or their businesses, often in the face of the greatest difficulties. Some sections were flooded over three times in succession, each new rise in the flood coming at a time when the farmers had just set out a crop to take the place of one destroyed by the previous overflows. Some struggled against new floods, others had to build new homes, or find new methods of earning a living.

The Red Cross pledged itself to assist every flood victim in need, and it has carried out this pledge. All summer its representatives remained on the scene of destruction working with local groups and guiding the process of restoration in the flood areas. By late August the Red Cross had assisted toward a new start a total of 90,111 families, and the work was still in full progress.

Great as the relief service has been in this single disaster, the Red Cross had a total of 75 the past year, including the Mississippi. There is no assurance that the country will not face some other trial at any time, for which this organization must be ready.

Therefore, once each year, the Red Cross urges everyone to join its ranks, that it may be ever ready for new service. The appeal for new membership this year will be made from November 11 to 24, during the Eleventh Annual Roll Call.

IN KALAMAZOO, MICH., the Consumers Power Co. is installing a district heating plant to serve the business district of Kalamazoo. Contract for underground installation has been given to the Northeastern Piping & Construction Corp. of North Tonawanda, N. Y. The Board of Water & Electric Light Commissioners of the city of Lansing has given a contract to the Northeastern Piping & Construction Corp. for the installation of a high pressure steam line in Lansing.

Throttling Suction Changes Pump Characteristic

POWER IS SAVED BY THROTTLING THE SUCTION OF A PUMP RATHER THAN THE DISCHARGE BUT CAVITATION AND UNSTEADY OPERATION MAY RESULT. BY BLAKE R. VANLEER*

PRACTICALLY EVERY modern plant is equipped with at least one centrifugal pump and some plants have many. Frequently a plant operator desires to know whether it will injure a centrifugal pump to close the valve on the discharge side while the pump is in operation. Sometimes he has a pump which is used for a general circulating pump which discharges to two different levels and it is necessary to throttle or decrease the quantity. Perhaps he has read in some of the pump manufacturer's catalogs that a centrifugal pump must not be throttled on the suction side but being one of the curious kind, he may have tried to throttle on the suction side of his pump and found that immediately the reading of his wattmeter decreased and he wondered why.

Properly designed, a centrifugal pump installation should have valves on both the discharge and suction side of the pump. These should be of the straight way gate type in order to reduce losses through them to a minimum and, where practical, should be of the rising stem type so that an operator can tell at a glance whether and how much the valve is open. Valves are necessary in order to shut off the water when it is necessary to clean or repair the pump.

CHANGES IN PUMP SPEED NOT USUALLY PRACTICAL

There are many installations where conditions require that the quantity pumped be decreased for short periods of time. If this decrease is permanent the most efficient way to accomplish it would be to change the speed of the pump.

This is usually impractical because most centrifugal pumps are direct connected to induction motors operating at definite speeds. The speed of an induction motor cannot be changed materially without changing the motor and this is not only expensive but the induction motor has certain definite speeds depending upon the frequency of the electric current and the number of poles in the motor. For example, with 60 cycle current the no-load speeds of an induction motor are 3600, 1800, 1200, 900 and 720 r.p.m. Actual operating speeds are from 2 to 5 per cent less on account of slip. From a practical operator's standpoint it is out of the question to attempt to change the capacity of a centrifugal pump direct connected to an induction motor by changing the speed of the pump. It is then necessary to find other means of reducing the quantity pumped.

CAVITATION IS ONE OF THE DANGERS ENCOUNTERED WHEN THE SUCTION IS THROTTLED

There is considerable justification for the admonition of pump manufacturers not to throttle on the suction side. Such a procedure may cause the pump to lose its prime. This is especially likely where there is leakage around the stuffing glands or where it is necessary to throttle the pump over a large range. Throttling on the suction side may also produce cavitation which sometimes causes pitting of the runner. Cavitation is usually accompanied by a popping, cracking sound within the runner or housing. Physically it means that the vacuum within the runner is so high and so nearly approaching the maximum possible that there is not available sufficient head or pressure at the entrance of the runner to force the water into the runner as fast as it is needed to fill up the vanes. As a result there is a separation of the water from the runner. This occurs only for an instant because as soon as the flow in the suction line is even slightly reduced all of the losses which are consuming the 34 ft. of head which

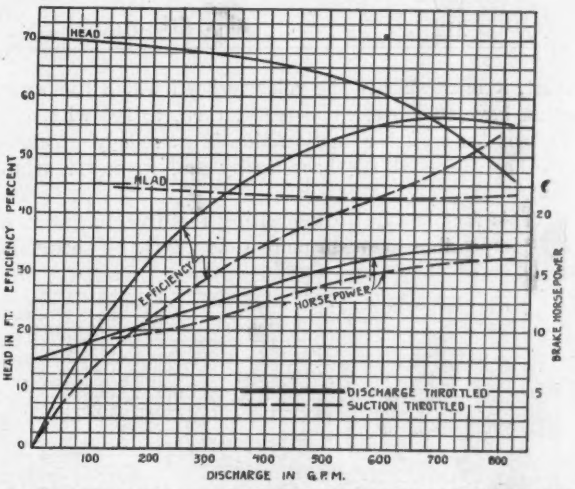


FIG. 1. THE TOTAL HEAD REMAINS PRACTICALLY CONSTANT OVER THE ENTIRE RANGE WHEN THE CAPACITY IS REGULATED BY THE SUCTION VALVE

is theoretically available at sea level, are materially reduced. This makes available additional pressure at the entrance to the runner and the process repeats itself, producing all the while a popping, cracking sound.

Ninety per cent of all centrifugal pump troubles occur on the suction side of the pump, hence it must not be forgotten that on this side of the pump the maximum theoretical head possible to produce at sea level is less than 34 ft. This head is materially lowered with an increase of altitude and still further lowered with an increase of temperature. This is shown in Tables I and II.

TABLE I. AT HIGH ALTITUDES THE THEORETICAL SUCTION LIFT OF A PUMP IS GREATLY REDUCED

Elevation in Feet	Maximum Suction Feet of Water
0	33.95
2000	31.4
4000	29.1
6000	27.1
8000	25.2
10,000	23.2

Most pump manufacturers will not guarantee their

*Assistant Professor Mechanical Engineering, University of California.

centrifugal pumps to deliver the full rated capacity unless operating under a total net head less than 15 ft. on suction side. This total net head on the suction side of a pump must do the following things: overcome entrance loss, loss through the foot valve, if there is one, friction loss through suction pipe, valve and fittings; lift the water the vertical distance from the water surface to the entrance of the runner, and last but not least, it must supply the velocity head which the water must have to move. It is easy, then, to see why each foot of head on the suction side is extremely precious. We have only 34 ft. theoretically and we never attain that.

TABLE II. INCREASED TEMPERATURES ALSO AFFECT THE HEIGHT OF THE THEORETICAL WATER COLUMN

Temp. Deg. F.	Maximum Suction Feet of Water
60	33
100	31.4
140	27.7
180	16.7
212	0.0

This fact has its compensating features, however, as it is impossible to waste more than 34 ft. by throttling on the suction side. Even approximately that much artificial head on the suction side will cause the pump to stop pumping. Not so on the discharge side. An artificial head can be built up there much higher than the original head against which the pump was operating when the discharge valve was wide open. And that in essence is why it is frequently possible to save power by throttling on the suction side of the centrifugal pump.

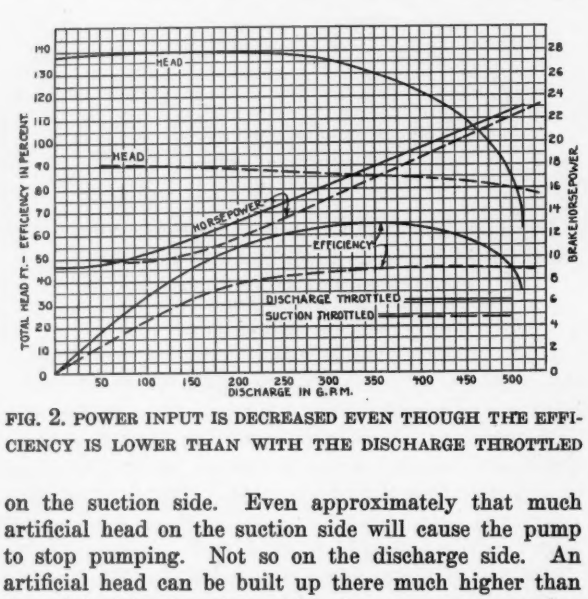


FIG. 2. POWER INPUT IS DECREASED EVEN THOUGH THE EFFICIENCY IS LOWER THAN WITH THE DISCHARGE THROTTLED

Characteristic curves, Figs. 1 and 2, show clearly why power can be saved by throttling in this manner. When the single stage, 5-in. centrifugal pump, Fig. 1, is delivering 750 g.p.m. under a head of 51 ft., it develops an efficiency of 56 per cent and requires 17.3 hp. If it is required to reduce the quantity of the pump to 450 g.p.m. and this throttling is done on the discharge side, the head mounts to 65.6 ft., the efficiency drops to 50.7 per cent and the power required is 14.7 hp. If the suction side of the pump is throttled the efficiency would be only 37.5 per cent, the head would be 45 ft. and the power would decrease to 13.3 hp., thus effecting by throttling on the suction side a saving of about 4 hp., or 3 kw., or approximately 25 per cent.

These characteristic curves also answer the question whether it will injure a centrifugal pump to close the valve on the discharge side. If the valve is completely closed, the quantity will then be zero and the pump will require the minimum amount of power to operate it, namely 7.5 hp. If the pump is left to operate under such conditions for a period of time there is danger that it may lose its prime. This is true especially where there are leaks around the stuffing box. If the pump is permitted to operate a longer time with the discharge valve closed, the entire power input being absorbed by eddy currents, steam may be generated and dangerous overheating result. Such accidents are rare.

Location of Valves May Change the Characteristic of the Pump

In the two stage pump, Fig. 2, characteristics differ somewhat in relation to each other and the saving is less because the valve on the suction side was located next to the pump, materially affecting the entrance angle of the water into the runner. This in turn caused the efficiency to drop much more than would normally have been the case. If this pump were delivering approximately its maximum capacity of 500 g.p.m,. against a head of 85 ft., it would have an efficiency of 45 per cent and require 22.7 hp. To reduce the quantity delivered 50 per cent or to 250 g.p.m. by throttling on the discharge side would increase the head to 138 ft. The efficiency would then be 58.5 per cent and the power required 14.7 hp. If this were accomplished by throttling on the suction side, the head would be increased slightly to 87 ft., that is, only 2 ft., and the efficiency would drop to 41.5 per cent. The power required to operate the pump would, however, be but 13.4 hp., a further saving of 1.3 hp., or about 10 per cent.

It is evident that it does not injure a centrifugal pump to throttle it on the discharge side and that with the discharge valve completely closed the pump will require a minimum of power. When throttling on the suction, the amount of power consumed is reduced, but such a method is dangerous because the pump may lose its prime and cavitation be produced which will wear out the impellor or casing. This cavitation effect will vary with the design and metal of the pump, character of the water and details of the installation. Under normal conditions a centrifugal pump should not be throttled on the suction except when recommended by and under the supervision of a competent engineer, thoroughly familiar with centrifugal pump operation.

The Harbison-Walker Refractories Co. at its East Chicago, Ind., works is installing continuous tunnel kilns, to replace the old round-type periodic kiln, in the manufacture of silica brick. Work of installing the new type of kilns will also be carried out at four other plants of the company. The new process has been previously used in manufacturing ordinary fireclay brick, but it is stated that this is the first installation for the production of silica brick.

Well-Type Furnace Tests at Huntley Station[1]

AT CHARLES R. HUNTLEY STATION, 1250-HP. BOILERS SHOW UNIT EFFICIENCIES IN EXCESS OF 85 PER CENT. BY H. M. CUSHING[2] AND R. P. MOORE[3]

DUTY IMPOSED on a steam generating plant operating in conjunction with a large hydro-electric system is characterized by a wide variety of requirements. The station must not only be capable of handling base load at reasonable efficiency where system conditions demand, but it must also supply highly dependable standby service, which means periods of low load factor operation and the ability to pick up load quickly in an emergency. Such a problem is presented in the Charles R. Huntley Station of the Buffalo General Electric Co., operating on the Buffalo, Niagara & Eastern Power Corp. system.

Originally the boiler house contained twelve 12,515-sq. ft. Babcock & Wilcox cross drum boilers with 9435-sq. ft. cast-iron economizers. The practical capacity of one of these boilers was about 130,000 lb. of steam per hour. Eleven of them were fired with duplex stokers and the remaining one with a long single stoker.

Plans for the extension called for one 60,000-kw. turbine requiring 670,000 lb. of steam per hour. Accordingly four boilers, one a spare, were added. With this equipment it was thought that the maximum capacity of the boiler units could be increased to 225,000 lb. of steam per hour required if the new unit was to be supplied by three boilers.

The boilers themselves are practically duplicates of the older boilers of the plant. They are of the horizontal tube sectional header cross drum type, 44 tubes wide and 11 tubes high, not counting the circulators. The tubes are 4-in. No. 7 gage, and the drum is 32 ft. long by 60 in. in diameter. The boilers have three-pass tubular superheaters located in the over-deck position designed for 275 deg. superheat with 320-lb. gage drum pressure. They are baffled for three passes with sloping baffles between the first and second pass. The total water heating surface of each boiler is 12,515 sq. ft. and the superheating surface is 7100 sq. ft.

TWO FURNACE DESIGNS IN USE

Furnaces for the four boilers are of the well type, but they are of two different designs, or rather three are developments from the tests on the first one. The furnace layout for boiler No. 13 is shown in Fig. 1. It consists primarily of an 8-ft. square well composed of 3¼-in. tubes spaced on 6-in. centers. Above the well the tubes on each wall continue parallel to each other, but flare out and pass through the brick walls of the furnace just under the boiler proper. This gives a furnace volume of 5076 cu. ft. between the furnace wall tubes and below the boiler tubes, of which 682 cu. ft. are in the well. The group of tubes on each side of the well are connected top and bottom through headers to the boiler drum. No provision is made for recirculation. The brick walls rest on the boiler room main floor and are of hollow construction with arrangements for tertiary air cooling.

Secondary air comes from a fan which discharges into an air space around the outside of the well. This air has been admitted into the well through a variety of opening arrangements. There is one burner in each of the four walls of the well, offset 2 ft. from the center so that the velocity of the jet causes cyclonic action and turbulence of the gases in the furnace.

In the other three furnaces, four water walls with refractory-faced blocks extend down from the boiler to within a few feet of the basement floor. There is practically no brick exposed in the furnace. The lower section forms the well which is 15 ft. 7 in. square and 7 ft. 6 in. deep. Above this the two sides extend outward to the full width of the boiler, giving a total furnace volume of 10,200 cu. ft. The exposed block surface amounts to 2044 sq. ft. per boiler. Each water wall has its separate recirculation through external piping. Make-up is supplied from the drum and the steam which is developed in the walls is returned to the drum. The furnace bottom is flat. It is composed of two courses of firebrick on a steel plate. A 6-in. layer of burned dolomite dished up at the sides is spread over the brick.

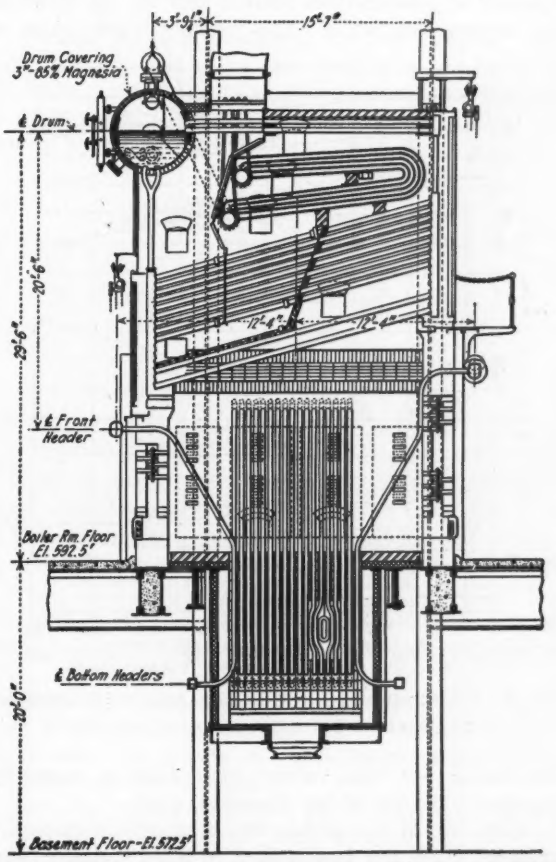


FIG. 1. VERTICAL SECTION OF BOILER NO. 13, SHOWING THE 8-FT. FURNACE WELL

Below the furnace bottom is a plenum chamber for

[1]From a paper presented at the First National Meeting of the A. S. M. E., Fuels Division, St. Louis, Mo., October 10-13, 1927.

[2]Chief Engineer, Buffalo General Electric Co.

[3]Mechanical Engineer, Buffalo General Electric Co.

secondary air. The presence of this air prevents overheating the plate and structural steel supports. The coal and all air required for combustion is admitted through four burners, one in each water wall. These burners are offset 4 ft. from the center line. They are of the Calumet type in which the opening for coal and primary air is 5 ft. in height by 2.4 in. across.

Ash Tapped Off in Molten State

No attempt is made in the furnace to chill the ash before it settles. On the contrary, with the design of furnace just described, it is important that the ash be maintained in a molten state until such time as it may be tapped off. Because of this the furnace may be operated at temperatures limited only by the effect on the water-cooled walls. This permits higher rates of

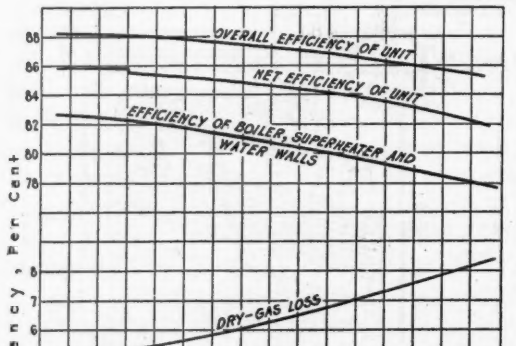

OVERALL EFFICIENCY OF UNIT
NET EFFICIENCY OF UNIT
EFFICIENCY OF BOILER, SUPERHEATER AND WATER WALLS
DRY-GAS LOSS
LOSS DUE TO BURNING H_2 TO WATER VAPOR
RADIATION AND UNACCOUNTED-FOR LOSSES
LOSS DUE TO COMBUSTIBLE IN FLUE ASH
LOSS DUE TO MOISTURE IN COAL
Efficiency, Per Cent
Equivalent Evaporation of Unit in 1000 Lb. per Hr.
Per Cent of Rating based on 14,560 Sq. Ft. of Heating Surface

FIG. 2. CURVE SHOWING THE LOSSES AND EFFICIENCY RESULTS OBTAINED FROM TESTS ON BOILER NO. 15

combustion per unit volume and, what is extremely important, the use of low-fusion-ash coals.

Handling of the molten ash originally presented a problem which has been solved in a very simple way. The slag tap hole has a cast-iron spout which discharges on to a high-velocity jet of water in a cast-iron housing known as the disintegrating box, which contains a sluicing system under the basement floor. This sudden cooling action shatters the slag into a granular product about the size of coarse sand, together with a considerable quantity of spun slag. The sluice discharges into a sump pit, from which the slag and water are pumped by 6-in. dredge pumps to a point from which the slag may be loaded on cars.

Important conclusions were drawn from a trial on boiler No. 13. As built, the unit is satisfactory for actual evaporations up to about 150,000 lb. of water per hour, which corresponds to 31,200 B.t.u. per cu. ft. of effective furnace volume. Above this the life of the wall blocks is too short, but good efficiencies without smoke may be obtained up to 200,000 lb. per hour actual evaporation. As it was necessary to obtain evaporations of about 225,000 lb. of water per hour to meet the design requirements, it was decided to increase both the size of the well and the total furnace volume and the design already described for the other three boilers resulted.

Proper criterion by which to judge the design of power plant equipment is its performance under the actual operating conditions obtaining in the plant for which the equipment was intended. These boilers have often exceeded 275,000 lb. per hr. actual evaporation for short periods of time with no difficulty whatever experienced in maintaining an actual output of 250,000 lb. per hour indefinitely.

Design Ideal for Standby Service

They have also proved themselves particularly valuable for making quick starts and stops. In the stoker fired section of the plant, the shortest time in which a cold boiler can be brought up to header pressure is 90 min. The new boilers do this easily in 40 min., and, when urgently required, even this time has been reduced. In shutting down it is like turning off the gas under a kettle; the boiling stops almost immediately.

Losses due to popping of the safety valves after a sudden drop in load are thus minimized. Even though the setting has practically no capacity for storing heat above the temperature corresponding to the pressure, cooling below this point is very slow. There being no furnace fire in the furnace when the boiler is out of service, it is practical to use tight uptake dampers. In 12 to 15 hr. the drum pressure drops about 100 lb. per sq. in., and 1800 to 2200 lb. of coal is required to bring it back to line pressure. It averages about 150 lb. of coal per hour to hold a boiler banked in this manner. With a tight damper and a tight setting, it is possible to relight a boiler every 12 to 15 hr. for 5 to 6 min. and have the boiler ready for service at any time within this 5 or 6 min. or less.

The ash pool on the furnace bottom is tapped about once in 24 hr. if the boiler has had any appreciable amount of service in that time. The boiler must, of course, have been in service some time when it is tapped. Any quantity up to 15 t. has been drawn off at one tapping.

Besides the wide range of capacity possessed by these boilers, which extends from 60,000 to 275,000 lb. per hr., there is great flexibility possible in the way in which they may be operated. Frequently only one mill has been used and, in this case, the secondary air has been supplied by either the other exhauster or the secondary air fan, or both. Using only one mill a continuous output of 200,000 lb. per hour has been maintained for 12 hr. with an average efficiency of 83 per cent.

Low Fusion Temperature Ash Coal Used

Fuel comes from several mines in eastern Ohio and western Pennsylvania. The proximate analysis shows about 35 per cent volatile, 50 per cent fixed carbon, 10 to 12 per cent ash, and the remainder moisture. As received the B.t.u. value of the fuel is about 12,500, the sulphur content from three to four per cent, and the fusion point of the ash from 1900 to 2000 deg. F.

In Fig. 2 the efficiencies and all the losses are shown

in curve form. The gross-efficiency curve is built up from the curves of losses so as to give it the proper shape. At the same time, it fairly represents the points calculated by dividing output by input. It is felt that this method has given a result nearest the truth. The curve for net efficiency comes by calculation from that of gross efficiency. The percentage of rating shown on the horizontal scale is based on the water-heating surface of the boiler, plus the surface of the exposed face of the block on the water walls of the furnace. Attention is called to the satisfactory manner in which the efficiency holds up even at the high ratings.

In conclusion it may be stated that the installation at Buffalo has demonstrated that low-fusion-ash coal may be burned in comparatively small furnaces at high maintained efficiencies, and that the direct firing system permits wide flexibility of operation with low cost per ton of coal handled.

Crawford Avenue Station Adds Two Units

INSTALLATION OF TWO NEW GENERATING UNITS TOGETHER WITH BOILERS GIVES STATION A TOTAL CAPACITY OF 424,000 KW.

WHEN CRAWFORD AVENUE Station of the Commonwealth Edison Co. of Chicago was built in 1925 it began operation with a total rated generator capacity of 160,000 kw. divided among three units, number one a 50,000-kw. Parsons machine, built in England, number two a 60,000-kw. General Electric unit and number three a 50,000-kw. Westinghouse machine. But a central station is never completed, and the last of the three units in the initial installation had hardly been put in service before plans were drawn and contracts let for a fourth turbine of 75,000-kw. capacity. The installation of this unit in 1926 utilized the remaining space available in the existing buildings.

The load requirements increased rapidly, however, and during the time the fourth unit was being installed a new addition was laid out for units 5 and 6. Unit No. 5 was placed in service August 23rd and unit No. 6 is expected to be ready for service in 1928. With the completion of the work of installing these units, the station will have a total rated generating capacity of 424,000 kw.

The size of the generating units has steadily increased. With the exception of the three initial machines which were all approximately 50,000 kw. capacity, each succeeding turbine-generator has been larger than its immediate predecessor. As already mentioned, unit No. 4 was rated at 75,000 kw. Unit No. 5 is rated at 88,000 kw. and No. 6 will be a 100,000-kw. machine.

Before the station reaches its ultimate capacity it is possible that four more units will be added and while it is fairly certain that additional units will be at least of 100,000-kw. capacity, nothing definite can be predicted at the present time. Development in the electric power field is so rapid that it is inadvisable to make any predictions in matters of this kind.

While the general engineering features of the new extension are similar to those of the initial installation, there naturally are some new features which incorporate later developments, and provide for the larger size of the last two units. The addition to the boiler room was made somewhat wider than the initial installation due to the fact that the new turbine units will require six boilers each instead of five. The turbine room and transformer rooms are the same width as in the first portion while the extension to the switchhouse is only about half as wide as the old, due to the fact that the vertical isolated phase arrangement is being used instead of the horizontal isolated phase system formerly used.

Turbine No. 5 is a General Electric machine. The high pressure turbine is connected to a generator of 33,000-kw. capacity at 85 per cent power factor running at 1800 r.p.m. and the low pressure to a 55,000-kw. generator running at 1200 r.p.m. A 2000-kw. auxiliary

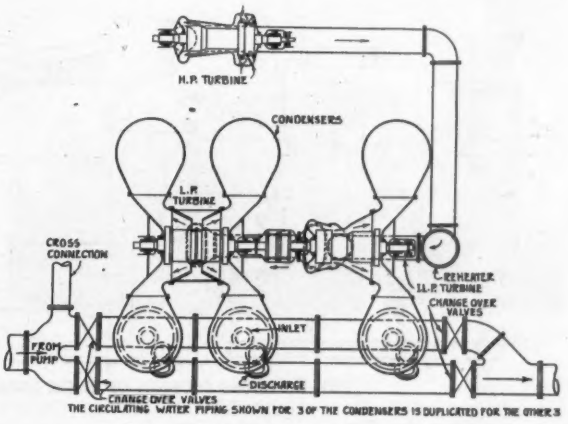


FIG. 1. PLAN VIEW OF UNIT NO. 6, A 100,000-KW. MACHINE WITH THREE CYLINDERS AND SIX VERTICAL CONDENSERS

generator for station supply is mounted on the same shaft with the high-pressure generator. Both number 5 and 6 units will operate on 550 lb. steam pressure with 725 deg. total temperature.

Unit No. 6 rated at 100,000 kw. is being built by the Westinghouse Electric and Manufacturing Co. and is of rather unusual design. The turbine is a three cylinder unit of which the high pressure drives a 45,000-kw. main generator and a 4000-kw. house generator while the intermediate and low pressure turbines coupled in tandem drive a 55,000-kw. main generator. Direct connected exciters are provided for all generators. Both high and low pressure elements operate 1800 r.p.m.

In both units, steam supplied to the throttle at 550 lb., 725 deg. total temperature, will be expanded to saturation in the high pressure elements and then reheated to about 500 deg. F. before entering the low or intermediate pressure elements.

The original installation was designed to carry the base load of the system and employed the reheat cycle with a special reheat boiler for each turbine. These boilers require considerable time to bring them into service or to take them out and consequently are not efficient for turbines that must be started every morning and shut down at night. The fourth unit was laid

out without reheating as the load on the system did not warrant more base load machines.

In order to secure some of the benefits of the reheat cycle, units 5 and 6 were laid out with live steam reheaters placed in the turbine room between the high and low pressure sections of the turbines. These reheaters are really closed heat exchangers and occupy much less space than the reheat boilers. Also the long and expensive reheat pipe connections between the turbine and boiler room are eliminated. These factors reduce the first cost of this type of reheat installation very materially and make such a system economical in the case of turbines having a comparatively low load factor.

The simplicity of the live steam reheater makes it easy to operate, so that it can be put into service and taken out of service quickly and with a minimum of operating complications. These reheaters are designed to resuperheat the steam for the low pressure turbines to about 480 deg. F. The reheater for Unit 5 is being furnished by the Superheater Co. but the one for Unit 6 has not yet been ordered.

The General Electric machine, unit number 5, has two 35,000-sq. ft. Worthington condensers. Circulating water for these condensers is furnished by two 57,000-g.p.m. centrifugal pumps.

A striking feature of Unit No. 6 is the three exhaust openings, each subdivided to discharge into two radial flow, single pass vertical condensers. Each of these condensers has a surface of 15,000 sq. ft., giving a total of 90,000 sq. ft., of condenser surface for the 100,000-kw. turbine. The six condensers are being supplied by the Westinghouse Electric & Mfg. Co., and will condense approximately 730,000 lb. of steam per hr. Steam jet vacuum pumps are provided with both the Worthington and the Westinghouse condensers.

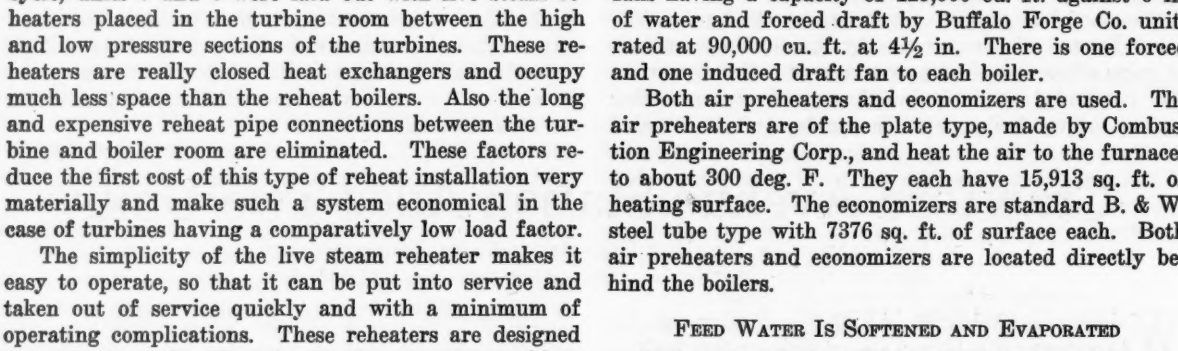


FIG. 2. CROSS SECTION OF HIGH PRESSURE ELEMENT OF THE 100,000-KW. UNIT

New Boiler Equipment

To serve the new turbines, 12 new boilers were installed, each rated at 1728 hp., having 17,280 sq. ft. of heating surface in the boiler and 3100 sq. ft. in the interdeck superheaters. There are six boilers to each generating unit. All boilers and superheaters are of Babcock and Wilcox Co. manufacture, and are fitted with forced draft chain grate stokers. Coke stokers, supplied by the Combustion Engineering Corp., will be installed under the boilers for both units.

The stokers are 24 ft. in width, have a grate area of 425 sq. ft. and like those in the older part are all motor driven. Induced draft is supplied by Sturtevant fans having a capacity of 125,000 cu. ft. against 6 in. of water and forced draft by Buffalo Forge Co. units rated at 90,000 cu. ft. at 4½ in. There is one forced and one induced draft fan to each boiler.

Both air preheaters and economizers are used. The air preheaters are of the plate type, made by Combustion Engineering Corp., and heat the air to the furnaces to about 300 deg. F. They each have 15,913 sq. ft. of heating surface. The economizers are standard B. & W. steel tube type with 7376 sq. ft. of surface each. Both air preheaters and economizers are located directly behind the boilers.

Feed Water Is Softened and Evaporated

Boiler water is heated by extracted steam from the main turbines. This water, obtained from the Chicago Drainage Canal, is first softened by means of a zeolite water treating system and then evaporated. The evaporators for No. 5 unit are Griscom-Russell units. No deaerators are installed because an entirely closed system is used in which the water passes from the condensate pumps directly to the boiler feed pumps.

The extraction heaters for Unit No. 5 were built by the Wheeler Condenser and Engineering Co., and those for Unit No. 6 by the Elliott Co. They were designed for a working pressure of 800 lb. per sq. in. and a test pressure of 1200 lb. Condensate from the live steam reheater is also used as feed water. This is delivered to a booster pump which sends it into the feed water system. The feed water enters the economizers at about 350 deg. F.

Electrical Features

In the electrical side of the new addition there is quite a marked difference from that of the old. This refers particularly to the switchhouse and bus galleries. Instead of using the horizontal isolated phase system, employed in the initial installation and at Calumet Station, the vertical isolated phase scheme is used. This makes possible a narrower switchhouse, occupying less ground space than it would if the horizontal isolated phase system were used, with a consequent reduction in construction costs.

For heavy switching, the FHD-17 General Electric type circuit breaker is used and is arranged for operation by the so-called ML-3 mechanism. This is a motor operated mechanism and is now standard for the FHD-17 breaker. A feature of this mechanism is that it can be installed on any of the phase floors, thus eliminating the need of an extra story. With this arrangement, the switchhouse occupies less than half the ground area occupied by the old portion of the switchhouse. The area between that occupied by the new switchhouse and that which it would have occupied had the former type of construction been used will be utilized for the installation of transformers.

Another feature of particular interest about the electrical equipment is the type of bus construction used. Instead of placing the laminations of the bus side by side in the usual manner, they are arranged so as to lay on three sides of a square. This construction is used in order to obtain a more uniform distribution of current in the bars. It has been found in practice as well as by experiment that the current distribution in the ordinary parallel bar type of bus is by no means uniform. In 1926 a number of experiments were made by engineers of the Commonwealth Edison Co. in which the current and heat distribution in various types of bus construction was determined and in these tests it was found that the square or rectangular type of bus was the most suitable for conditions such as exist at Crawford Ave.

In the first section of the station the circuit breakers on the generators and in the bus were rated at 4000 amp. In the new addition or, at least, for unit No. 5, 6000-amp. switches are used. This 50 per cent increase in switch capacity required considerable development work.

As was the case with the initial installation, the new addition was designed by Sargent and Lundy, Inc., of Chicago in co-operation with the engineers of the Commonwealth Edison Co. The electrical features were designed entirely by the engineering department of the Commonwealth Edison Co. and constructed under its direction by the company's construction department.

DURING THE PERIOD from October 22 to November 13, a conference on engineering materials is being held in Berlin, Germany. The program of papers contains about 200 lectures by scientists and practicing engineers. While these papers, which are read at the Technical University of Charlottenburg are intended chiefly for engineers, an exhibition of interesting materials arranged in the Neue Ausstellungshalle (New Exhibition Hall) on the Kaiserdamm will be an attraction to the general public also.

Three groups of engineering materials will be dealt with: iron and steel, non-ferrous metals and electrical insulation materials. More than 200 testing machines are being shown in operation to illustrate the latest methods of testing. Details of the conference and exhibition may be obtained from the Geschaftsstelle der Werkstofftagung, Berlin N W 7, Ingenieurhaus, Germany.

IF YOU are doing justice to your own job, you are too busy to worry about what the other fellow is doing.

It Pays to Encourage Community Improvement

BY LESTER G. HERBERT

SUCCESS is difficult to measure, weigh or define. It is certain, however, that money is not the entire measure of success, although it is increasingly evident that public spirit, wisely directed, as evidenced by industrial leadership, is highly profitable; and that the concern, corporation or industry which does its part to make life happier, more wholesome, more enjoyable and more inspiring for its employes and their neighbors, will lose nothing thereby in point of dollars and cents. This is directly in line with the article "Beautiful Surroundings Are an Asset to Industry," which appeared in the October 1 issue.

To be sure it costs money. It costs the farmer money to plant the seed from which later he reaps an abundant

FIG. 1. NATIONAL CASH REGISTER PLANT IN 1888

harvest,—but it pays him to do it. If he spends no money for seed, he has no harvest, and so his original economy is of a most short-sighted and defeating character.

There are many concerns in industry today which refuse to pay out the cash for seed in the way of general improvements, and while those concerns save the initial investment, they sacrifice the later benefits for themselves and for others.

There are several features in the case to consider, by no means the least being the *kind* of help attracted and held by an organization.

In our modern studies of efficiency and the elimination of unnecessary waste, we have found that labor turnover represents a large sum annually for industry. It costs amazing sums to tolerate disaffected, indifferent and discontented help. It costs extremely heavily to bridge the gap between the experienced or the semi-experienced worker in our employ, and the new-comer who must be trained and fitted to render the service required and for which he is paid. And it costs again most heavily in actual property values represented by cash investments and re-sale possibilities.

Frequently industry owns property, workmen's homes or auxiliary buildings in the neighborhood of the parent institution, and if the whole locality is run down and desolate and uninviting, it is not possible to inventory such property for more than it will actually

bring. In fact, some business experts declare that the rate of inventory should be what the property will bring at a sale behind which is a good deal of pressure.

So all in all, it is profitable from every standpoint to keep the environment of industry in as progressive and even beautiful a condition as possible. One of the outstanding examples of this policy is that of the National Cash Register Co. of Dayton, Ohio.

Under the far-visioned leadership of the late John H. Patterson, Slidertown, as the locality was called, became one of the most beautiful and valuable parts of the city of Dayton, Ohio, the general health of the community was greatly improved, the workmen became more contented and prosperous, and the company itself grew rapidly from a small one to one of international importance and having world-wide recognition for its enterprise and the quality of its output.

It is not always given to us to trace cause and effects conclusively over a period of years, but in the accompanying illustrations we have a striking "Before" and "After" demonstration of the practical application of these very principles.

In Fig. 1, we have a picture of the National Cash Register plant in 1888—and it's quite a plant at that! At present day values, it would represent a large payroll and a large investment. But compare it with Fig. 2, which was taken in 1925 and shows an airplane view of the same parent organization, while throughout the whole of this part of the city and stretching away into the country, are club houses, golf links, parks, breathing spaces, schools and inspirational centers which have made the whole city of Dayton vastly richer and more progressive in every sense of the word.

In fact, the example of public-spiritedness of this

FIG. 2. AIRPLANE VIEW OF NATIONAL CASH REGISTER PLANT AND VICINITY IN 1925

Workmen who are contented, interested, enthusiastic and prideful of their homes and the business of which they are a part, will produce higher grade outputs than those who are slip-shod, careless and under the impression that all their employers care about them is to knock all the work energy out of them possible with the least recompense they can get away with.

When you come right down to it, this is the tap root of the struggle between labor and capital. "Welfare work" is a term coming into disfavor, as it savors too much of my Lord and Lady Bountiful and patronizing benevolences. The American workman of today aims to own his own home, to drive his own car, to enjoy a Victrola or radio or anything else that is up-to-the-minute and to give his family reasonable advantages; and so when the work becomes co-operative in type and self-respect is maintained on both sides, the results are bound to be more satisfactory.

We have made the broad and rather sweeping statement that money spent wisely in a public-spirited way, is the seed of an abundant harvest,—a harvest toward which there are many contributory factors.

company has set a pace for others to follow, the value of which can never be estimated.

Yes, it pays good measure, shaken down, pressed together and running over, for industry to encourage community as well as plant betterment.

TRANSFER OF 20 electric utility properties in Arkansas and Oklahoma, owned by Dierks Lumber & Coal Co. of Kansas City, to the Insull interests has recently been completed, according to an announcement by F. H. Dierks. Frank Kemp of the Central and Southwest Utilities company of Dallas, Tex., and A. Lieberman, vice-president of the Southwest Gas & Electric Co., represented the Insull interests.

GENERALLY SPEAKING, hand lubricating, where the oil is supplied by an oil can, is the most inefficient and wasteful of all methods and wear and deterioration are almost inevitable. It is nearly impossible to oil a machine by hand and do a good job. The intermittent application does not give results, nor does it give the necessary continuous lubrication at all times.

Specifications Governing the Purchase of Coal

COAL SELECTION IS PROBABLY THE MOST IMPORTANT SINGLE FACTOR BECAUSE ONLY THROUGH PROPER SELECTION CAN COAL BEST SUITED TO EXISTING PLANT EQUIPMENT BE BOUGHT. BY MORGAN B. SMITH*

INDUSTRIAL STEAM GENERATION is now emerging from that long primitive period in which steam plant operation was merely operation and in which careful coal selection and purchase, beyond consideration of delivered cost, was seldom seriously considered. Industry, the country over, is awakening to the benefits of proper coal selection, the greatest single factor involved in efficient steam plant operation.

In this country industrial steam plants at large show an average boiler and furnace efficiency of 56 per cent, whereas 70 per cent may be reasonably expected. Careful coal selection, followed by comparatively inexpensive plant betterment and more intelligent plant operation will bring about this increase in efficiency. Steam plant efficiency can be raised only by co-ordinating coal selection, better plant operation, betterment and proper maintenance of plant, adequate records of plant performance and installation of instruments for the guidance of plant operators and for obtaining comparative operating data.

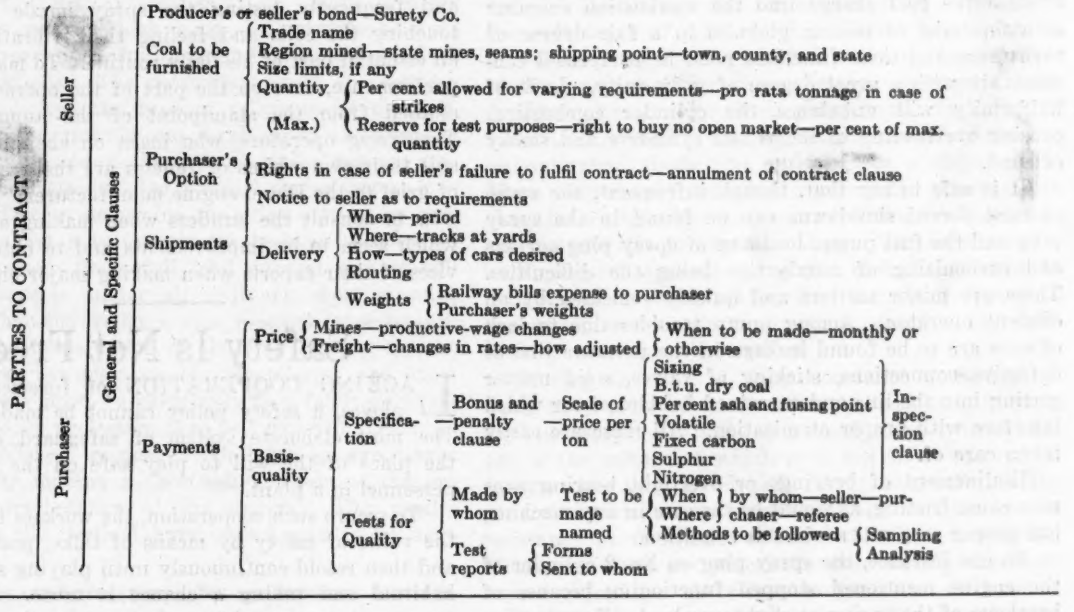
ALL DEPARTMENTS MUST WORK TOGETHER

It is apparent that coal selection and purchase cannot be divorced from plant operation unless plant efficiency is considered of little moment. Purchasing in general cannot be efficient without thorough coordination of its function with that of plant operation and management. Real team work among men of widely different training, experience, knowledge and points of view must be attained before maximum efficiency can be reached. Purchasing agents are urged to line up their function in coal selection and purchase with that of the plant engineer and the boiler plant operator.

Many items enter into coal selection, of which the boiler plant itself is of primary importance. The type and size of boilers, volume and shape of combustion chamber, firing methods, type of grates, average rating, furnace construction and type of refractories must all be considered. General characteristics of the coal, including district from which it comes should be studied and complete analysis of the delivered coal made. Burning characteristics and cost, moisture, ash and sulphur must all be considered together so as to determine a base cost for each coal which logically may be the cost per 1,000,000 B.t.u. or the cost of 1000 lb. of steam in each case. It is fairly general practice to sell 1⅛ and 1¼-in. slack as 2-in. slack. The buyer should know that 1¼-in. slack as a rule contains approximately 25 per cent less fuel value than the 2-in. slack. Considerable expense can also be saved by carefully specifying the type of car in which shipments shall be made and the proper routing and scheduling of coal shipments.

Points of view of the purchasing department and the power plant operators are often widely different, and too often irreconcilable. They must be brought together in such a way that the coal buyer will see and understand the viewpoint of the plant operator; that the latter shall appreciate the purchasing department's problem of coal selection and purchase, and that the management shall understand why the plant operator has asked for plant betterment.

OUTLINE SPECIFICATIONS OF COAL, SHOWING THE ITEMS WHICH SHOULD BE CONSIDERED FOR PROPER PROTECTION OF BOTH PURCHASER AND SELLER



*Engineer, General Motors Corp., Detroit, Mich. Abstract of paper presented at First National Meeting of the A. S. M. E. Fuels Division, St Louis, Oct. 10-13, 1927.

Diesel Engine Maintenance

SPRAY PLUG AND FUEL PUMP SHOULD BE GIVEN INTELLIGENT CARE. BY W. MARX KAUFMANN

DIESEL engines have, as a rule, proved reliable in operation but, like all other mechanisms, lack of proper care will bring undesired results. Herewith are discussed some problems which came to the attention of the writer in connection with a 3-cylinder, 225-hp., vertical, solid-injection engine, operating on 4-stroke cycle. It was equipped with bypass regulating fuel system, spring-loaded spray nozzles, overhead inlet and exhaust valves and cam-operated air starting valves.

Owing to conditions in the plant, this engine was subjected, at frequent intervals, to strenuous overload periods.

In the solid injection type, the fuel injection valve or spray plug plays a vital part, as not only must the pump deliver fuel to the spray plug at pressures ranging from 4000 to 6000 lb. per sq. in., but the plug must atomize the fuel charge into the combustion chamber as a fine mist of minute globules in a fair degree of turbulence and these functions must be performed continuously with a great degree of uniformity. Lack of uniformity will unbalance the cylinder combustion, causing overloading of individual cylinders and smoky exhaust.

It is safe to say that, though infrequent, the cause of most forced shutdowns can be found in the spray plug and the fuel pump, breaking of spray plug springs and carbonizing of nozzle tips being the difficulties. These are minor matters and quickly remedied by an efficient operator. Among pump troubles due to lack of care are to be found leakage in the pressure line at defective connections, sticking of valves, solid matter getting into the line and entrained bubbles of air which interfere with proper atomization. All these are easily taken care of.

Misalinement of bearings or overtight bearing caps may cause heating, as would be the case in any machine, but proper care will avoid this condition.

In one instance, the spray plug on No. 2 cylinder of the engine mentioned stopped functioning because of breakage of the spring at slight overload. Examination showed a break near the center with coarsely granulated fracture, evidently due to inferior material in the replacement spring wire. Reducing compression on the coils and using the vanadium steel springs supplied by the makers of the engine eliminated all spring breakage.

During another short overload run, the exhaust from No. 1 cylinder was extremely black. Indicator cards from all three cylinders showed unequally distributed load with loss of power in No. 1 due to poor combustion. When the spray plug was removed, formations of spongy carbon tubes were found about the nozzle orifice. Taking the valve apart, it was noted that in regrinding the valve plunger had become seated too deep in the nozzle plate, i. e., the plunger had too sharp an angle, resulting in a burred edge or ridge on the seat. This caused an uneven spray and a dribble instead of instant burning so that oil was distilled, the carbon residue remaining on the orifice. The accumulation grew and caused further dribbling until a jagged carbon tube was formed.

Filing off the burr and regrinding both plunger and seat to a flatter angle gave perfect performance. Expert skill is needed in such grinding to insure perfect alinement of valve and seat.

On this type of engine the pump plungers were packed and, after a period of service, leakage past the packing became serious. Tightening of the packing nut and increasing the number of layers, helped much but completely satisfactory results were obtained only after the introduction of lapped plungers, thus eliminating packing entirely. Accumulation of sediment in the fuel oil was eliminated with little difficulty by placing a fine mesh wire screen filter in the fuel suction pipe, thus entrapping these solids before they reached the pump.

Considering maintenance in general, the experienced operator learns to know his engines by the uniform rythmn of their mechanical and explosive impulses. Any irregularity in the beat should be enough to start him investigating. Keeping an ever watchful eye on the fuel tank, lubricating oil, outlet water temperatures and frequently testing the spray nozzle springs by touching the coils and feeling their vibration, become an essential part of his daily routine. To maintain good performance, care on the part of the operator must be studied from the standpoint of the human element. Tampering operators, who insist on changing parts to suit their own whims or fancies are the greatest source of grief to the Diesel engine manufacturer. It is always wise to consult the builders when making substitutions which seem to be improvements and to obtain the services of their experts when making major changes.

Safety Is Not Free

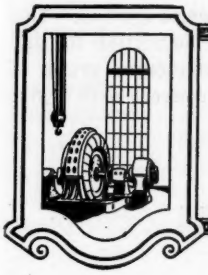
LACKING COOPERATION of foremen and employes, a safety policy cannot be made a success. The most elaborate system of safeguard cannot take the place of the will to play safe on the part of the personnel in a plant.

To secure such cooperation, the workers must be sold the value of safety by means of talks, posters, letters, and then resold continuously until playing safe becomes habitual and taking a chance is taboo. More talks, more posters, more letters but not to the extent that they become a bore or a commonplace, also the arousing among foremen of conscious responsibility for the workers in their charge are essential.

Such talks and letters should combine general principles with concrete illustrations from the daily routine of the plant, covering causes of accidents, handling of material, mechanical guards, dangers from inexperience, responsibility for accidents, benefits of safety to the worker, use of accident records, responsibility for one's self and for others.

Vigilance is the price of success but saving of one life or prevention of one serious accident is worth all that a safety policy costs in expense and effort.

PLANS ARE NOW being drawn for an installation of three 3500-kw. mixed pressure turbines at the Central Forge Plant of the Chevrolet Motor Co., Detroit, Mich. These turbines are to take exhaust from the steam hammers at 5 lb. with full automatic control. Albert Kahn, Inc., is engineer for this project.



ELECTRICAL MACHINERY FOR LIGHT AND POWER

Calculating Short Circuit Current Values

DESCRIBING A METHOD WHEREBY THE SHORT CIRCUIT CURRENT FOR A SHORT AT ANY POINT ON THE SYSTEM CAN BE PREDETERMINED ACCURATELY. BY E. MCCORMACK

EVERY POWER COMPANY regardless of its size or the type of its feeder system must face the problem of protection of its apparatus against short circuits. This protection usually consists of oil circuit breakers operated by relays which must differentiate between normal or operating conditions and abnormal or short circuit conditions. The determination of the settings for the relays and the type of relays to be used depends on the magnitude and direction of the currents in the various parts of the network under various conditions of short circuit. On a radial feeder system it is an easy matter to determine the relay setting by proportion, i. e., set it to operate the breaker on overload of three or four times full load current and it will function properly under all ordinary short circuits. However, when the feeder system becomes more complicated, by the introduction of the ring or loop system, and networks are used on the secondaries, the short circuit current must be calculated to a fairly accurate degree if proper protection is to be furnished. This has been accomplished by one of the large eastern power companies by making a thorough analysis of the impedance characteristics of the system. The results obtained by this method have been found to be very satisfactory.

Resistance and reactance for generators, reactors, transformers, regulators, etc., are usually to be found in the specifications furnished by the manufacturer for the individual unit. The resistance of wire or cable of standard manufacture can be obtained from any wire table but the reactance must be obtained by calculation to suit the individual conditions of each operating company. This reactance may be found from the inductance per unit length of cable which is determined as follows:

The varying flux which is set up around a conductor carrying current and which links with any other wire in the field, will set up an opposing e.m.f. in that wire.

Without going into the derivation of the formula, it can be shown that the inductance of a line is expressed by the following equation:

$$L = \left[\left(0.1404 \log_{10} \frac{d}{r} + 0.01525\right)\right] \div [1000]$$

in which d = the distance between centers in centimeters, r = the radius of each wire in centimeters and L = the inductance in henries per 100 ft. of line.

The reactance in ohms will then be 157 × L for 25 cycles and 376 × L for 60 cycles.

Inspection of this equation shows that the distance between the lines is the largest factor in determining the inductance of a line. This distance is the equivalent three phase spacing which is equal to the cube root of the product of the three distances between the individual phases. For three phase work the values of resistance, reactance, and impedance are calculated for an equivalent single line and not for a single phase. These values are obtained by using the constants in ohms for a single wire and using the line to line voltage and not the line to neutral voltage. The constants for each piece of apparatus and for each line should be determined as closely as possible, for the accuracy of the result is dependent on the accuracy with which these constants are determined.

Having determined these constants a method of using them must be developed which will suit the various operating conditions. A method which is independent of the voltage at which each section of the system operates has been developed. It is assumed that the generated voltage remains constant and that the contact resistance at the point of short circuit is negligible. These conditions are practically true during the short time required for the relays to function. A base or constant is chosen, expressed in kv.a. The actual value of this constant has no bearing on the result as it is used only as a transfer medium. If this base kv.a. be divided into the square of the kv. of any section the result will be an impedance which we will call the base impedance.

$$Kv.^2 \div Kv.a._{base} = Z_{base} \qquad (1)$$

If the ohmic impedance of each section is then carefully obtained as described above and expressed as a percentage of this base impedance, it is possible to add or subtract these percentages in the same way that the original impedances may be treated.

$$Z \div Z_{base} \times 100 = \% \text{ impedance} \qquad (2)$$

and combining equations (1) and (2) we have

$$\% \text{ impedance} = (Z \times Kv.a._{base}) \div (Kv.^2 \times 10) \qquad (3)$$

The kv.a. base by its assumption represents the total available energy in the circuit, consequently if there were no impedance present the current which would flow in the circuit would be dependent on the voltage of the section. If we call this value I

$$I = Kv.a._{base} \div Kv. \qquad (4)$$

This current is of course a theoretical value and the actual current will be less due to the impedance present, or

$$I_{s.c.} = I \times 100 \div \% \text{ impedance} \qquad (5)$$

Combining equations (4) and (5) we have

$$I_{s.c.} = \frac{\text{Kv.a.}_{base} \times 100}{\text{Kv.} \times \sqrt{3} \times \% \text{ impedance}} \qquad (6)$$

Inspection of equations 3 and 6 shows that the kv.a. base has no effect on the value of the current, but is used to eliminate consideration of the difference in voltage of transmission, generation, and distribution.

When the various sections, lines and pieces of apparatus have been expressed as percentages of the base impedance a single line diagram is made in which each section of impedance is represented as a circle with a horizontal diameter. The space above the diameter is reserved for the percentage impedance which it represents, and the space below for a designating number.

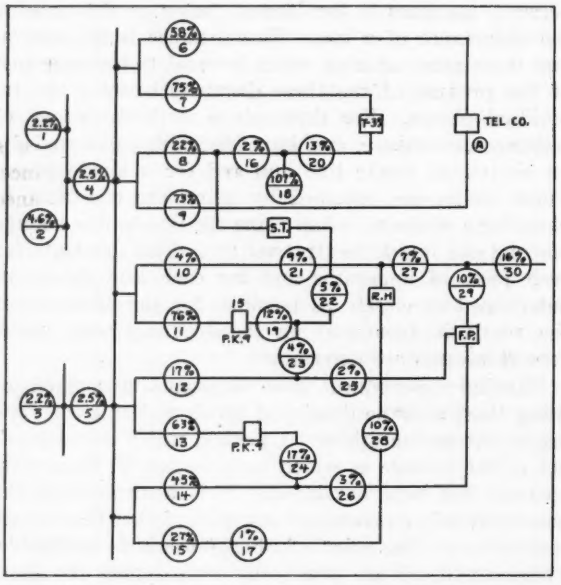


FIG. 1. DIAGRAM OF SYSTEM WITH IMPEDANCE VALUES PLOTTED

A diagram ready for use is shown in Fig. 1. A short circuit is chosen at some point and the system solved either mathematically by Kirchhoff's Laws or by means of a calculating table.

When a calculating table is not available and the mathematical solution must be resorted to, there are a number of labor saving devices which are advantageous.

Obviously, when several reactances are connected in series without any intervening branches, the total reactance of the group is equal to the sum of the individual reactances or $X_T = X_1 + X_2 + X_3$.

Also, when several reactances are connected in parallel, the total reactance of the group is equal to the reciprocal of the sum of the reciprocals of the individual reactances: or

$$\frac{1}{X_T} = \frac{1}{X_1} + \frac{1}{X_2} + \frac{1}{X_3}$$

In solving a network an absolutely essential method is that known as the equivalent star delta method. This permits of substituting a simple star connection for any delta. For example, take a delta connected group of impedances as shown in Fig. 2 and convert it to a star connected group.

With such an arrangement,

$$A_1 = \frac{B_1 \times B_3}{B_1 + B_2 + B_3}$$

$$A_2 = \frac{B_1 \times B_2}{B_1 + B_2 + B_3}$$

$$A = \frac{B_2 \times B_3}{B_1 + B_2 + B_3}$$

Obviously the converse of this will be:

$$B_1 = \frac{A_1 \times A_2 + A_1 \times A_3 + A_2 \times A_3}{A_3}$$

$$B_2 = \frac{A_1 \times A_2 + A_1 \times A_3 + A_2 \times A_3}{A_1}$$

$$B_3 = \frac{A_1 \times A_2 + A_1 \times A_3 + A_2 \times A_3}{A_2}$$

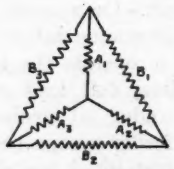


FIG. 2. ILLUSTRATING CONVERSION OF DELTA CONNECTED GROUP TO A STAR CONNECTED GROUP

Still another important consideration is the 3-winding transformer. These units may be represented by a star connected reactance, the value of which may be determined from the reactance between the various windings, together with the kv.a. capacity of each winding. For example, let us assume a 3-winding transformer with a 15,000-kv.a. primary, 10,000-kv.a. secondary, and 10,000-kv.a. tertiary. The reactance as given in the specifications is 10 per cent on 15,000 kv.a. from primary to secondary, 8 per cent on 10,000 kv.a. from primary to tertiary, and 5 per cent on 10,000 kv.a. from secondary to tertiary. If we represent the equivalent reactance to the primary X_A, of the secondary X_B, and of the tertiary X_C, the following formulas will be found to be true:

$$X_A = \frac{X_{AB} + X_{AC} - X_{BC}}{2}$$

$$X_B = \frac{X_{AB} + X_{BC} - X_{AC}}{2}$$

$$X_C = \frac{X_{AC} + X_{BC} - X_{AB}}{2}$$

Before substituting in these formulas it is necessary that all reactance percentages be converted to the same base—let us say 10,000 kv.a. Therefore, X_{AB} will be

reduced to X_{AB} $\frac{10{,}000}{15{,}000}$ or 6.67 per cent on the 10,000 kv.a. basis

Substituting

$$X_A = \frac{6.67 + 8 - 5}{2} = 4.83 \text{ per cent}$$

$$X_B = \frac{6.67 + 5 - 5}{2} = 3.33 \text{ per cent}$$

$$X_C = \frac{5 + 5 - 6.67}{2} = 1.66 \text{ per cent}$$

This transformer would then be represented by a star connected reactance with values as indicated in the preceding equations. It is possible but not usual for one of these equations to have a negative sign. In this case the sign is treated as part of the value.

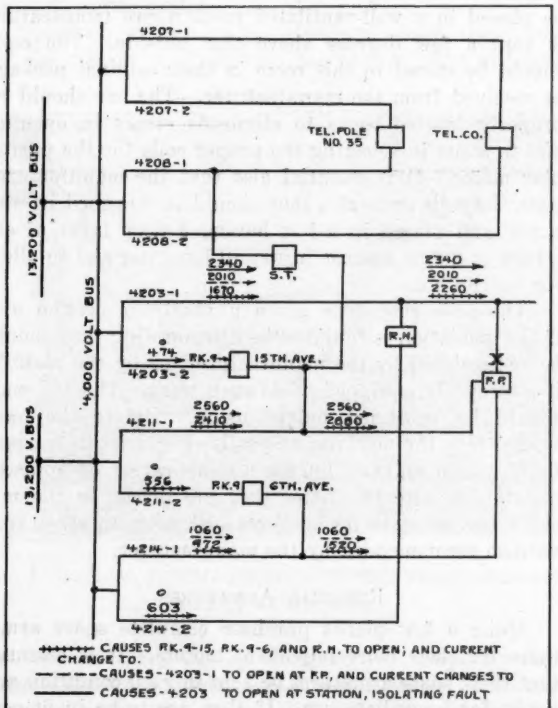


FIG. 4. SYSTEM SHOWN IN FIG. 1 WITH CURRENTS IN VARIOUS BRANCHES INDICATED WHEN A SHORT CIRCUIT OCCURS AT X

In the case of open delta banks, T connections, 3 phase to two phase, etc., it is usual to consider that the system is symmetrical without introducing appreciable error. Feeder regulators introduce a reactance in the line which varies with the position of the rotor from 10 per cent to 30 per cent of its own rating and is usually taken as the former value.

With the aid of the foregoing information, any simple network may be solved or reduced to one simple reactance and resistance. When this has been done, the total short circuit current is found by dividing this impedance by the line voltage at the point under consideration. If it is desired to find the short circuit

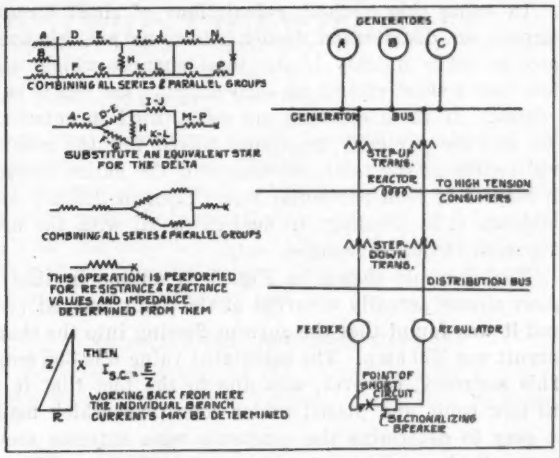


FIG. 3. SKELETON DIAGRAM SHOWING STEPS FOLLOWED IN SOLVING A SIMPLE PROBLEM

current in each branch of the system, this method is reversed, keeping in mind the fact that the current in any branch of a divided circuit is inversely proportional to the resistance of the branch.

Figure 3 shows a skeleton of the various steps to be followed in solving a simple problem. This procedure is carried out once for reactance and once for resistance, and the two results combined to get the total impedance to the short circuit.

When the values of current in the various branches have been determined for a given short circuit they are indicated as shown in Fig. 4. A study of these diagrams forms the basis for determining the relay settings and a final print is issued showing the final settings and the type of relays to be used. Figure 5 is a typical example of a complete final print.

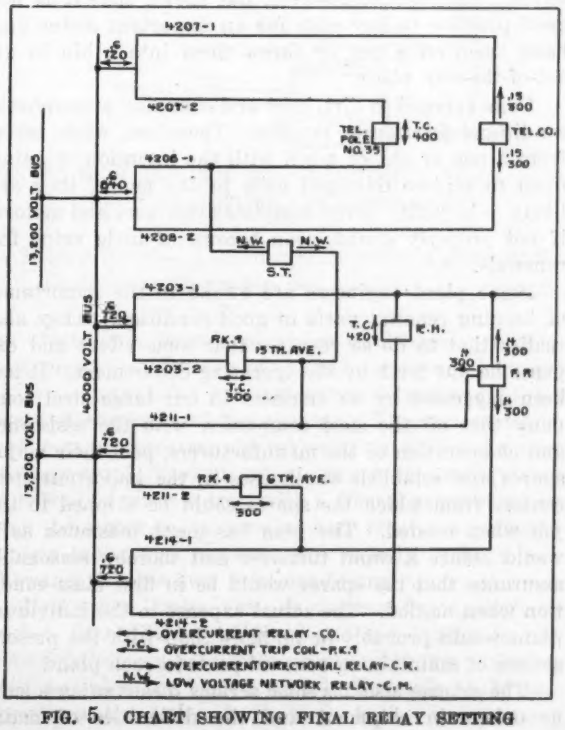


FIG. 5. CHART SHOWING FINAL RELAY SETTING

In using this method, calculations of short circuit current on distribution feeder additions and changes may be made quickly if the total current which will flow into a short circuit on each distribution bus is calculated. If these currents are substituted in equation (6) and the per cent impedance solved for, the results will represent the total impedance of the entire system in respect to each particular bus. Then in making calculations it is necessary to deal in detail with the distribution feeder impedances only.

The example shown in Fig. 1 is unique in that a short circuit actually occurred at the point marked (A) and it was found that the current flowing into the short circuit was 350 amp. The calculated value was 355 amp. This accuracy, however, was due to the fact that it is all new cable and placed under conditions which made it easy to determine the constants with extreme accuracy. Under ordinary conditions an accuracy of about 5 per cent may be expected if reasonable care is taken in the preliminary work.

Care of Spare Parts for Electrical Equipment

UNLESS SPARE COILS AND ARMATURES ARE STORED PROPERLY AND KEPT FREE FROM MOISTURE, THEY MAY PROVE USELESS WHEN PLACED IN SERVICE

IN A RECENT number of the Electric Journal, G. P. Wilson, steel mill engineer of the Westinghouse Electric & Mfg. Co., presented an article on the care and maintenance of renewal parts for electrical equipment. Although this was written with the steel plant in mind, the principles outlined are applicable to other industries.

Most operators are accustomed to thinking that care and maintenance are needed for the equipment in operation only, and that spares will take care of themselves. Experience, however, has shown that it is not good practice to buy coils for an important motor and hang them on a peg or throw them into a bin in an out-of-the-way place.

Coils exposed to dirt, dust and changing atmospheric conditions deteriorate rapidly. Therefore, when taken from a peg or out of a bin with the intention of using them to replace damaged coils in the motor, they are likely to be unfit. Even complete armatures and motors, if not properly stored, soon become of little value for renewals.

Some plant engineers are awake to the importance of keeping renewal parts in good condition. They also realize that to do so requires that some effort and expense be put forth by the operating department. It has been suggested by an engineer in one large steel company that all the steel companies, with the assistance and co-operation of the manufacturers, pool their major spares and establish warehouses in the important steel centers from which the spares could be shipped to the job when needed. The plan has merit inasmuch as it would assure a rapid turnover and thereby reasonable assurance that the spares would be in first class condition when needed. The actual expense to the individual plant would probably be no more than with the present system of maintaining renewal parts in each plant.

The scheme also has some serious disadvantages such as delays in shipment and the difficulties of maintaining records. With experience, a satisfactory system of record keeping could doubtless be devised; but time would unavoidably be lost in shipping. This is a serious disadvantage which might prove disastrous to the plan.

The proper maintenance and care of spares, irrespective of the plant or method, require that some system be followed, and to do this a certain amount of time and money must be expended, particularly on the maintenance of spare coils and armatures. The following brief outline offers some recommendations and suggestions on how these renewal parts can be maintained.

Renewal Coils

It is essential that spare coils retain their original freshness. This requires that they be stored properly. They should neither be kept in a room that is dry and hot, nor should they be kept in a damp cellar, but should be placed in a well-ventilated room where temperature is kept a few degrees above that outside. The coils should be stored in this room in their original package as received from the manufacturer. The box should be properly labeled so as to eliminate errors in opening and to assist in selecting the proper coils for the particular motor. It is essential also that the manufacturer pack the coils properly; they should be wrapped in wax paper and placed in a box having a deep layer of excelsior to guard against injury in handling and to allow for ventilation.

The coils should be given a yearly inspection and if the insulation is found to be deteriorating they should be re-insulated by the manufacturer, or by the plant if it is properly equipped to do such work. The coil ends should be re-tinned before using. Before they are wound into the machine, the coils should be thoroughly dried out in an oven having a temperature of approximately 100 deg. C. After they are placed in the machine the coils should be varnished with an air-drying varnish recommended by the manufacturer.

Renewal Armatures

Quite a few plants purchase complete spare armatures for their more important motors. It is essential that these spare armatures be kept in good condition and ready for immediate use. If they are to be in fit condition when placed in service they should be stored in a suitable room or building. This building should be heated electrically so as to maintain the temperature a few degrees warmer than the outside air, thus preventing moisture from accumulating on the armature and weakening the insulation. Electric heat is preferable to steam heat, because of the liability of moisture, due to steam leakage, when steam is used.

The armatures should be inspected at least once a year and a megger test applied. If the insulation shows signs of deterioration, one coat of a good grade of baking varnish should be applied and baked on. Caution should be used in making the megger test. The instructions furnished with the instrument should be carefully read and followed, so as to insure correct results.

The journals on the armature shafts should be carefully treated with an approved rust resisting compound. These journals should be inspected occasionally and compound added as needed to keep them in good condition.

Comments on Steam Trap Operation

STEAM TRAP IS A SIMPLE AND RUGGED APPARATUS, REQUIRING ONLY A LITTLE ATTENTION TO KEEP IT IN BEST OPERATING CONDITION

IN THE MODERN power plant and factory, the steam trap renders most efficient aid to good operation by removing condensate and air from various steam condensing surfaces. There are, of course, two general classes of traps: non-return traps which discharge the condensate to some vessel of lower pressure than that from which the condensate comes; return traps, which send the condensate directly back to the boiler. Although there are many types and makes of these two classes, the differences between the makes and types are largely mechanical, representing the efforts of each designer to make a valve mechanism that will function in the best possible way.

Selection of any of the standard steam traps now on the market will not lead the power plant engineer

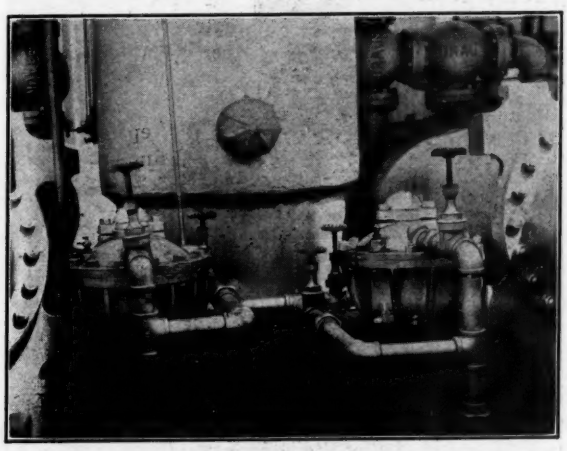


FIG. 1. TYPICAL INSTALLATION OF BUCKET TRAPS DRAINING A HEAT EXCHANGER

far astray. They are all designed for simplicity and ruggedness. The operating engineer, however, is usually responsible for the minor difficulties encountered in operating them, rather than the traps themselves. He seems usually to forget that they are pieces of machinery, often with a moving part, and although he will spend much thought and care on his prime movers and boilers, he often neglects to give the steam trap the most elementary care.

Steam traps will stand a great deal of abuse and when properly applied will function longer with less attention than many other steam plant appliances. Occasionally, however, because of wear on valve seats, unforeseen accumulations of dirt in the condensate handled and so on, they will not operate as they should. Too often, in such a case, the bypass will be opened and no further attention given to the trap. Instead of this, the proper cleaning and adjustments should be made at once and the trap put back in service.

Proper maintenance of steam traps is best carried out by a regular periodical inspection. In the case of traps operating at medium and high pressures, wear on the valve and seat is higher than with low pressure traps and these items should be carefully checked and replacements made as needed. In thermostatic traps, the thermostatic element should be inspected thoroughly. A good method of testing these is to set up a test trap at some convenient point in the plant and actually test the element in a trap body. This is probably the quickest and most satisfactory test that can be made.

SELECTING TRAP OF PROPER CAPACITY

Selection of a trap of the proper capacity and type for a given service is of extreme importance to secure

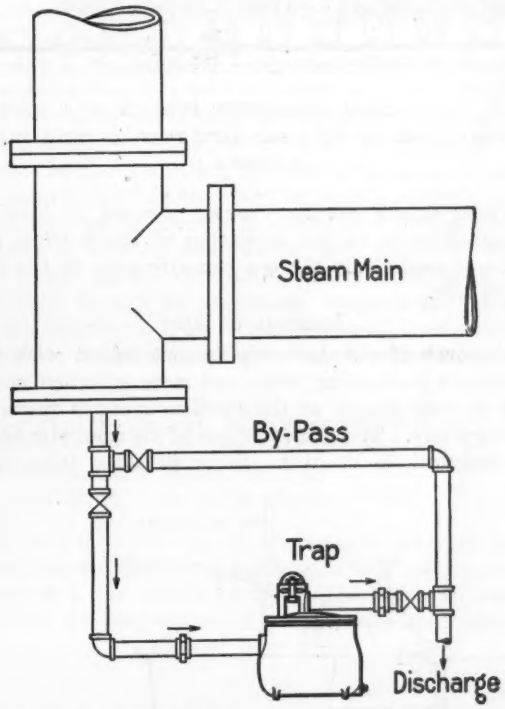


FIG. 2. HIGH PRESSURE TRAP DRAINING A STEAM LINE, SHOWING SIMPLICITY OF CONNECTIONS

good trap results. The amount of water a given orifice will discharge is represented by:

$$Q = C\sqrt{P}$$

in which Q is pounds of water discharged per hour, P is pressure difference in pounds per square inch and C is a constant for a given orifice determined by the size and character of the opening. The various manufacturers of traps supply tables of capacities for each of their traps, worked out on this or a similar basis. It is well to select a trap with a liberal excess capacity over the water to be handled and from the manufacturer's tables the engineer can usually make a safe allowance for his own local conditions.

Non-return traps are of various types, such as bucket, float, tilting and thermostatic. Piping connections for these are extremely simple, as shown, including only an inlet and outlet pipe and usually a bypass. Sometimes the body of the trap itself contains a by-

pass, controlled by a valve, in which case the external bypass is not needed. The piping should be of full size, of course, and free from obstructions. A strainer in the line just ahead of the trap is a convenience, although several makes of traps have strainers incorporated in them. The engineer should also make sure that the pressure in the space to be drained is enough higher than the outlet pressure to give movement of the maximum amount of water to be handled.

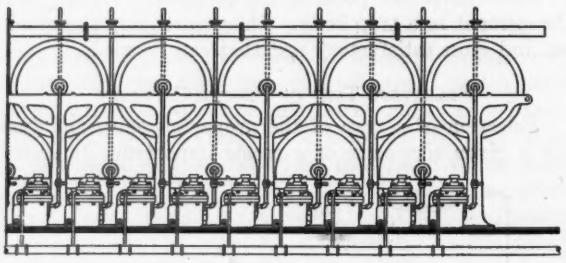


FIG. 3. EACH STEAM CONDENSING SURFACE OF A UNIT IS PREFERABLY SERVED BY A SEPARATE TRAP, AS ON A PAPER MACHINE

Traps should not be wrongly accused of blowing through because of the formation of steam when the discharge passes into the low pressure area on the discharge side.

Removal of Air

Removal of air that may become mixed with the condensate is receiving more and more attention nowadays in trap design as the problem receives more intensive study. The various types of thermostatic traps are designed to do this. Some of these take their

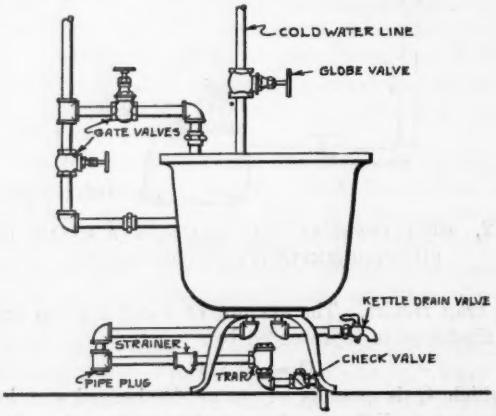


FIG. 4. A STRAINER AHEAD OF THE TRAP PREVENTS MANY DIRT TROUBLES

action from an expanding liquid or an expanding bellows or other element, acting directly on the valve. The thermostatic trap is usually open when cold, discharging the air as steam is admitted. Thermostatic traps are sometimes used as high pressure air vents on mechanically operated traps. One make of float trap incorporates a thermostatic element for this purpose. In another type of bucket trap, air is expelled by being drawn up into the discharge tube, after discharge of condensate has taken place by the fall of the water in the discharge tube to the level in the trap.

In case thermostatic traps are not installed or no other method is provided for automatically expelling air, the trap is usually provided with a vent at the top which can be opened for this purpose. In many plants, one of the operator's routine duties is to inspect all the traps every day to make sure they are not air-bound.

Non-return traps are now designed for pressures from a few ounces to 600 lb. Many types of traps are designed for installation directly in the lines to be drained, like a valve, without any other supports being necessary. It is recommended that each separate condensing surface of a given unit be served by a separate trap, as shown in Fig. 3.

Return Traps

Where it is desired to save all the heat in the condensate and return it to the boiler—especially when

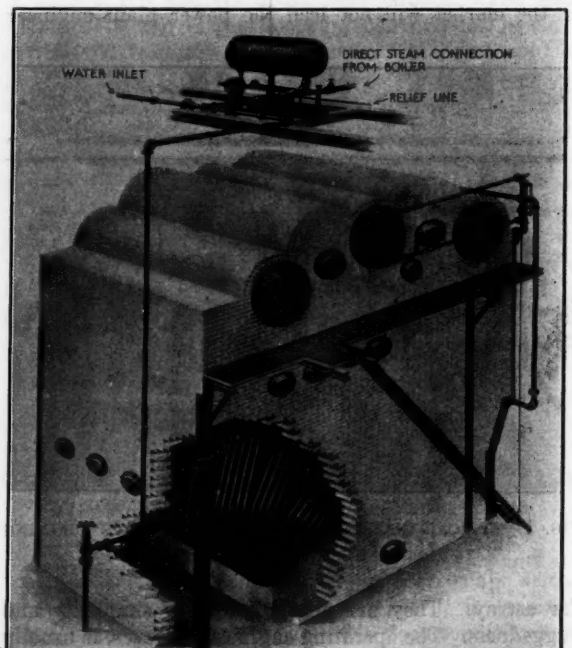


FIG. 5. RETURN TRAP, ALWAYS AT LEAST 4 FT. ABOVE BOILER WATER LINE, FEEDS THROUGH INDEPENDENT CONNECTION SUCH AS BLOWOFF

the condensate is of high temperature—the return trap is used. This usually consists essentially of a chamber alternately filling with condensate and emptying into the boilers by gravity. The chamber is connected with the steam admitting valve in such a way that when the chamber has filled with condensate, it tilts, opening the steam valve which puts the chamber under boiler pressure. The water then flows by gravity into the boiler. Then a counterweight returns the chamber to position and after discharge a vent valve relieves the pressure in the chamber so that condensate can flow in again. This action is intermittent, as distinct from that of some types of non-return traps which can collect and discharge condensate at the same time. Vacuum

and condenser traps, used on heating systems for low pressure work, are of the same general type, except that in the condenser trap, instead of venting the chamber, a water spray condenses any steam remaining and thus lowers the pressure.

The return trap must always be installed above the water line of the boiler to be served. A head of 4 ft. is generally accepted as the minimum permissible to provide sufficient force, but wherever possible, it should be all that the head room will allow. The trap should feed the boiler below the water line, preferably at the coolest portion of the boiler and at a place where it will readily enter the boiler circulation. Return traps are often installed to feed through the blowoff, as shown in Fig. 5. The feed connection should always be independent of any other lines to the boiler such as pump or injector lines. Also, full boiler pressure must be utilized at the steam valve, otherwise pressure in the trap cannot be equalized.

On the discharge side of the return trap, precautions should be taken to lower resistance to discharge. Pipe lines of ample size, nothing but swing check valves, few elbows and the shortest practicable pipe runs should be used. Submerged location of check valves, especially on the inlet side, has been advocated to eliminate the possibility of check valve hammering.

To check up on the operation of a return trap, inspection should be made of both steam and vent valves. When the chamber is in filling position, the steam valve should be closed tight and the vent valve as wide open as possible. When the chamber is in emptying position, the vent valve should be tightly closed and the steam valve wide open.

Double Return Trap System

It sometimes happens that the pressure on the condensate lines to the return trap is not enough to raise the water to the return trap on top of the boiler. This is often the case in heating systems. In such a case, the condensate can be led to a return trap at the lowest point of the system. This is a lifting trap and it discharges the condensate to the trap above the boiler.

It is of interest to note that when using return traps for boiler feeding, an accurate measurement can be made of the amount of water fed. Since each dump of the trap requires the same weight of water, the number of dumps can be read by a counter attached to the trap chamber.

It will be obvious to every reader that the foregoing discussion does not pretend to cover all the details of the various types of traps on the market with all their applications. Our object is rather to touch on those points of trap operation that are common to all and to emphasize the fact that regular inspection followed by care of traps as soon as anything goes wrong, are the secrets of securing good results from traps. Owing to conditions beyond the control of the trap, it is often unjustly blamed for conditions which need not exist if the engineer will give it only a small fraction of the attention he gives to his other power plant equipment.

A New Application of Receiver Separators

They Have Been Used in Protecting Superheater from Scale by Assuring Supply of Dry Steam from the Drum. By C. E. Joos*

OPERATION of boilers at low ratings is fast passing and with the trend toward higher ratings the need of steam purification becomes more evident. It no longer creates a sensation to operate boilers at 400 per cent of rated capacity. Some of the larger industrial plants and central stations are even exceeding this. It is difficult to picture the rapid ebullition and disturbance that takes place at the steam liberating surface under these conditions. Even under the best water conditions, as where surface condensers and evaporators are installed, the mechanical carryover at high ratings may be sufficient to reduce the superheat materially, and to cause deposits in the steam lines, superheaters and turbines. Even though evaporators are installed, solids find their way into the boiler through condenser leakage and from foaming and priming of evaporators. Although the solids entering the feed may ordinarily be considered trifling and inconsequential, they may concentrate in the boiler to appreciable quantities.

To illustrate the quantity of water and solids carried over with moisture, suppose a 1000-hp. boiler is operated at 400 per cent of rating and that the boiler water concentration is but 100 grains per gallon. Steam containing 2 per cent of moisture from such a boiler would carry with it in a month's time approximately 208,000 gal. of concentrated water, containing 2975 lb. of solid matter in solution. This moisture would probably be evaporated in the superheater and the solids would remain there to cause deposits or would be carried along as a fine dust or powder. The steam, in passing through the turbine, would gradually become saturated

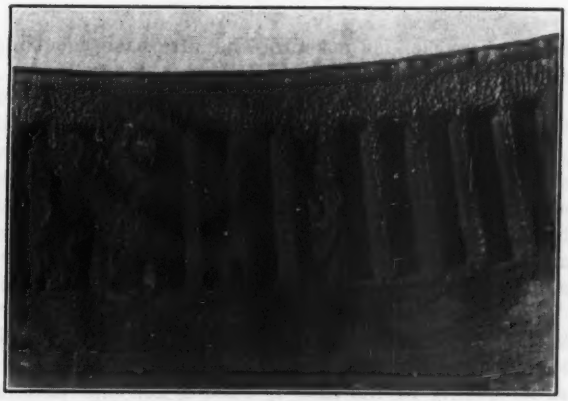


FIG. 1. TURBINE BLADE DEPOSITS DUE TO DIRTY STEAM

and the probabilities are that this dust would adhere to the blading at the dew point of the steam and beyond.

If slugs of water are carried along with the steam the damage may be more pronounced than with constant entrainment. Where boiler water is treated, the boiler alkalinities are made up chiefly of caustic soda,

*Cochrane Corporation, Philadelphia, Pa.

which readily attacks brass, dissolving out its zinc. The suspended matter usually carried over adds to the cutting effect of caustic soda by acting like a sand blast. Where valves are made of iron, this corrosion and erosion are not so noticeable as with brass valves, but interfere with proper functioning, so that a valve that cannot be tightly closed is a frequent occurrence.

The effect of steam contamination on turbine blading is well illustrated by Fig. 1. The accumulation of dirt on turbine blades is usually not the only difficulty

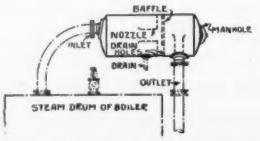


FIG. 2. RECEIVER SEPARATOR INSTALLED BETWEEN OUTLET OF BOILER AND SUPERHEATER INLET

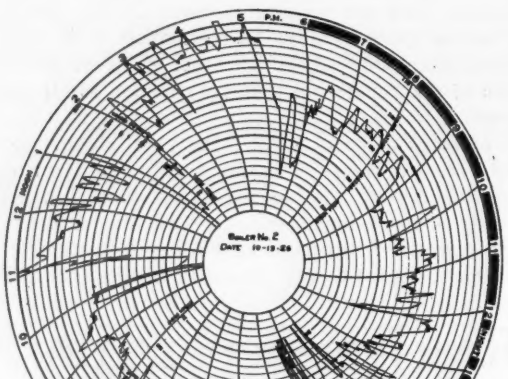


FIG. 3. CHARACTERISTIC FLOW METER RECORD, SHOWING LOAD ON BOILERS

to be overcome, for moisture and dirt have a cutting effect, which may ruin the entire rotor of a turbine.

Because of the efficiency and capacity of the receiver type of separator, it has been used for a number of years, principally on saturated steam lines to engines and has only recently been applied between the boiler and the superheater inlet. The receiver separator has been successful before the control valve of an engine and similar places remote from the actual steam generating plant. A receiver type separator of correct design placed between the boiler steam drum and superheater inlet will, taking into account the limiting velocities for complete separation, storage capacity, etc., give steam quality results entirely suitable for superheaters. In addition to giving a good quality of steam, the receiver separator has large storage capacity for the separated water, so that its effectiveness in stopping slugs of water is not entirely limited by the capacity of the trap which drains the separator.

If these separators are located sufficiently high above the boiler drum, the drain may be taken back to the boiler which is permissible if the steam contamination is due to mechanical entrainment of moisture rather than to high concentration. For an illustration of how a separator of this type is placed between the boiler steam drum and the superheater inlet, the reader is referred to Fig. 2. Such an installation, however, is not always possible, especially where the saturated steam outlet is taken through the bottom of the steam generating drum.

A test on an installation like that shown in Fig. 2 was made under conditions that were very severe as to character of load and average water conditions. The

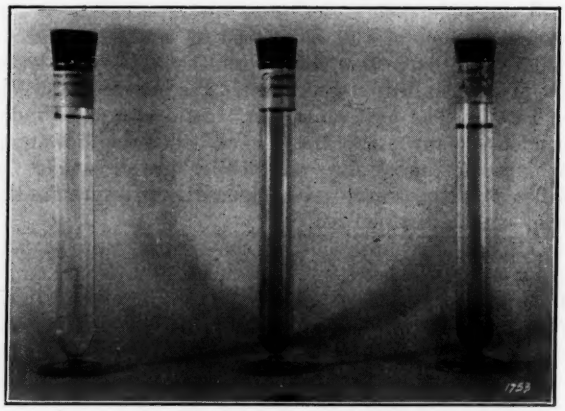


FIG. 4. SAMPLES OF CONDENSED STEAM AFTER SEPARATOR, CONDENSED STEAM BEFORE SEPARATOR AND BOILER WATER, RESPECTIVELY

LOG OF CALORIMETER TESTS

Time	Calorimeter T1	Calorimeter T2	No.1 T2c.	Per cent Mois.	Per cent Rating	Steam Temp.	Time of No.1 Discharge	Trap discharge duration in seconds
1:30	365	299	302	0.23				
1:33	365	299	302	0.18				
1:36	365	299	302	0.18				
1:39	365	299	302	0.18				
1:42	365	299	302	0.18				
1:48	365	299	302	0.18	200	535		
1:48	364	299	302	0.18				
1:51	364	299	302	0.20				
1:54	364	299	302	0.20				
1:57	363	299	302	0.20				
2:00	363	299	302	0.20	195	530		
2:03	365	299	302	0.18	195			
2:06	363	298	301	0.23				
2:09	365	298	301	0.25				
2:12	365	298	301	0.25			2:11	83)Represents
2:15	363	297	300	0.25	210	540	2:14	13)about 12.7%
2:18	365	298	301	0.25			2:19	12)moisture
2:21	365	298	301	0.25			2:11	17)initially
2:24	365	298	301	0.25			2:22	51)present in
2:27	365	299	302	0.18				steam.
2:30	363	299	302	0.20	200	540		
2:33	365	299	302	0.18				
2:36	367	299	302	0.25				
2:39	363	300	303	0.15				
2:42	363	299	302	0.20				
2:45	363	299	302	0.20	190	540		
2:48	363	299	302	0.20			2:49	120
2:51	365	299	302	0.18				
2:54	363	299	302	0.20				
2:57	363	298	301	0.23			2:57	43)Represents
3:00	364	298	301	0.23	210	540	2:59	22)about 18.3%
3:03	363	298	301	0.20			3:00	15)moisture
3:06	361	298	301	0.20			3:02	15)initially
3:09	359	298	301	0.13				present in
3:12	359	297	300	0.20				steam
3:15	357	297	300	0.12	190	505	3:17	11
3:18	357	297	300	0.12				
3:21	351	296	299	0.20				
3:24	357	296	299	0.20				
3:27	357	296	299	0.20				
3:30	359	296	299	0.25	200	525		
3:33	362	296	299	0.20			3:34	14)
3:36	363	297	300	0.26			3:36	14)
3:39	365	298	301	0.15			3:38	18)Represents about
3:42	363	298	301	0.25			3:39	19)25.4% water
3:45	361	297	300	0.25	210	530	3:39½	37)initially pre-
3:48	363	297	300	0.26			3:40	40)sent
3:51	363	297	300	0.26			3:42	119)
3:54	363	297	300	0.26			3:44	138)
3:57	365	298	301	0.25			3:46	17)
4:00	365	300	303	0.20	200	530	3:47	15)
Average				0.21				

T1 -- Observed temperature upper thermometer of calorimeter
T2 -- Observed temperature lower thermometer of calorimeter
T2c - Lower thermometer readings corrected for "normal".

588-hp. boiler used water which originally contained 20 grains total solids and which was treated in softening system. The concentration of salts in the boiler ran from 200 to 300 grains per gallon. The load conditions, as shown by a flow meter chart are shown in Fig. 3. In spite of this, the steam delivered to the superheater was practically dry. Besides taking throttling calorimeter

readings, samples of steam withdrawn from ahead of and following the separator were condensed and tested for salt concentration. Comparison of these results with the salt concentration in the boiler water gives some idea as to the amounts of moisture carried over and remaining after separation.

Figure 4 shows the amounts of mud contained in the condensed steam leaving the separator, in the condensed steam before the separator and in the boiler water. The presence of sludge in the steam is not uncommon in a great many plants and results in clogged up superheater tubes, turbine blade deposits, cut valves, etc. The measurement of trap discharges under priming conditions, as indicated by Fig 3, showed that the separator was removing as much as 40 per cent of moisture from the steam.

Similar tests were run at the same plant when using 5 grain feed water. While priming was not so severe it nevertheless occurred to an extent that would cause severe operating difficulties if the water were not removed.

These tests, tabulated herewith, were conducted according to the A. S. M. E. standards, using a perforated sampling tube having twenty-three ⅛-in. holes drilled in spiral rows. The throttling calorimeter was fitted with an ⅛-in. orifice and the entire instrument was well covered with hair felt. Tests when operating the boiler at a load of 0 to 50 per cent of rating with fresh water indicated a normal correction of 3 deg. F. for the calorimeter thermometer readings. In addition to the calorimeter tests given, samples of steam were condensed and none of the samples so collected showed a trace of soda alkalinity, although the concentration of soda in the boiler was in excess of 35 grains per gallon.

Practical experience shows and superheater manufacturers generally agree that steam of the quality indicated in the table will not cause superheater deposits or deposits and erosion within steam turbines. The amount of moisture removed was calculated from the duration of the trap discharge and the ratings, the capacity of the trap having been determined by actual weighed tests.

Steam Accumulator Smooths Boiler Load Peaks

VARIATION of load to the maximum degree is experienced in a plant of the Philadelphia & Reading Railroad, which hauls three loaded coal cars up a 2000-ft., 18 per cent grade at a speed of 30 to 40 mi. an hr., then stops entirely. The haul takes 60 to 80 sec. and the shutdown is for 2 min. From zero to 5000 hp. every 3 min. all day is certainly a variable load condition.

This pays because it saves a 30-mi. roundabout haul with bad tunnels and heavy grades, but the load factor is terrible to contemplate.

Located at Frackville, Pa., it is an outlet for the anthracite mines of that region. Twin 54 by 72-in. engines are used, running non-condensing and controlled by Stephenson link for reversing, the speed being entirely regulated by the throttle. A 2½-in. steel cable hauls up loaded cars, three at a time and, at the same time, lets down a string of empties.

Operation is at 160 lb. boiler pressure and 130 lb. at the engine, the pull on the boilers for steam being as erratic as the load on the engine.

To steady the load on the boilers, a Ruths accumulator is being installed with capacity of 4600 cu. ft. and 2700 lb. This will store up heat in the water during the 2-min. shutdown and deliver it for steam making during the peak demand, the pressure range being from

FIG. 1. THIS INCLINE CAUSES THE PEAKS

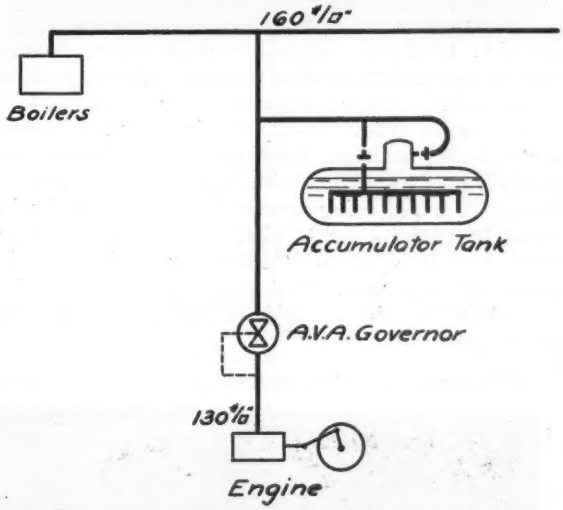


FIG. 2. STEAM ACCUMULATOR ACTS AS HEAT RESERVOIR

160 lb. to 130 lb. The tank is 10 ft. diam. by 62 ft. long, supported on cradles and connected into the system, as shown in Fig. 2, by a single pipe.

Control of steam flow is effected by a pressure governor which closes when the engine is shut down so that steam from the boiler at 160 lb. charges the accumulator. When the engine starts, the governor valve opens and maintains 130 lb. at the throttle, boilers and accumulator supplying steam together. It is unique in accumulator practice that boiler pressure is allowed to vary with accumulator pressure. In the usual form, the Ruths system has an additional governor to hold boiler pressure constant.

It is estimated that, by the reduction in peak demand on the boilers, the plant can be run on 5 boilers instead of 7 as heretofore. Also the installation of the accumulator and one new stoker has obviated the need for four new stokers.

Modern Ice Plant at Kansas City

PLANT NO. 3 OF THE AMERICAN ICE CO. IS ELECTRICALLY OPERATED AND GIVES EFFICIENT PERFORMANCE. BY C. CAMP*

FROM THE ACCOMPANYING pictures of the exterior and interior of the new ice plant of the American Ice Co. at Kansas City, Mo., it can be seen that nothing was spared in the design and construction of this building to make it attractive. At the same time, it is efficient. The American Ice Co. operates three plants in Kansas City, Mo., all of the high pressure raw water motor driven type. No. 1 plant was placed in operation in June, 1923; No. 2 in May, 1925; and No. 3, with which this article is concerned, in June, 1927. This plant, because of its more recent construction is more efficient and modern than either Nos. 1 or 2, although all plants are characterized by high operating efficiency.

In order properly to describe the machinery and apparatus installed in this plant, it will be convenient to classify the equipment under the headings generally used by those familiar with the construction and operation of ice plants.

AMMONIA COMPRESSORS

Three 10 by 10-in. vertical single-acting enclosed type compressors are installed, each with 60-hp., 100 per cent p.f., 164-r.p.m., 3-phase, 60-cycle, 440-v. General Electric synchronous motors, mounted directly on compressor shaft. These compressors are equipped with high pressure relief valve, full size starting bypass, safety heads, multiple discharge poppet valves and double trunk type piston, with suction valve in head of piston. A splash oiling system is used, combined with forced feed lubrication to piston pins and main bearings. All oil is filtered through strainers placed on outside of compressor. Each compressor rated at 23 t. ice making capacity at 22½ lb. suction pressure and 185 lb. head pressure.

*Chief Engineer, American Ice Co.

High side equipment consists of two vertical shell and tube type ammonia condensers, each 38 in. in diameter by 16 ft. high, and each having 1108 sq. ft. of effective condensing surface and a horizontal ammonia receiver, 36 in. in diameter by 14 ft. long, equipped with a gage glass.

Both condensers and receiver are of forge welded construction, each equipped with high pressure relief valves. The condensers are rated at 69 t. ice making capacity, with 85 deg. F. water.

A liquid type oil separator is used equipped with purge valve and gage glass, and a 12-in. diameter by 4 ft. long horizontal non-condensable gas purge drum with internal liquid cooling coil installed in liquor line between condensers and receiver.

FREEZING SYSTEM

The freezing system employed is that generally known as the horizontal group freezing system, all evaporating coils being placed on bottom of tank and cans made up in stationary groups. The freezing tank is 35 ft. 6 in. by 74 ft. 0 in. by 63 in. deep, made of ¼-in. thick tank steel with special circulating bulkheads and agitator troughs for the group system; construction is all riveted and is 32 cans wide by 34 cans long.

Evaporating coils consist of 24,100 ft. of 1¼-in. continuously welded ammonia pipe, without any flanged joints below brine level. Ice cans number 1088, are rated at 300 lb., arranged in 136 groups of eight cans each. The framework is of steel arranged to support can groups and multiple four-can oak covers.

A vertical shell and coil type accumulator is installed. This has internal liquid cooling coil and the lower portion is submerged in brine of the tank.

Freezing tank coils are operated "flooded" with

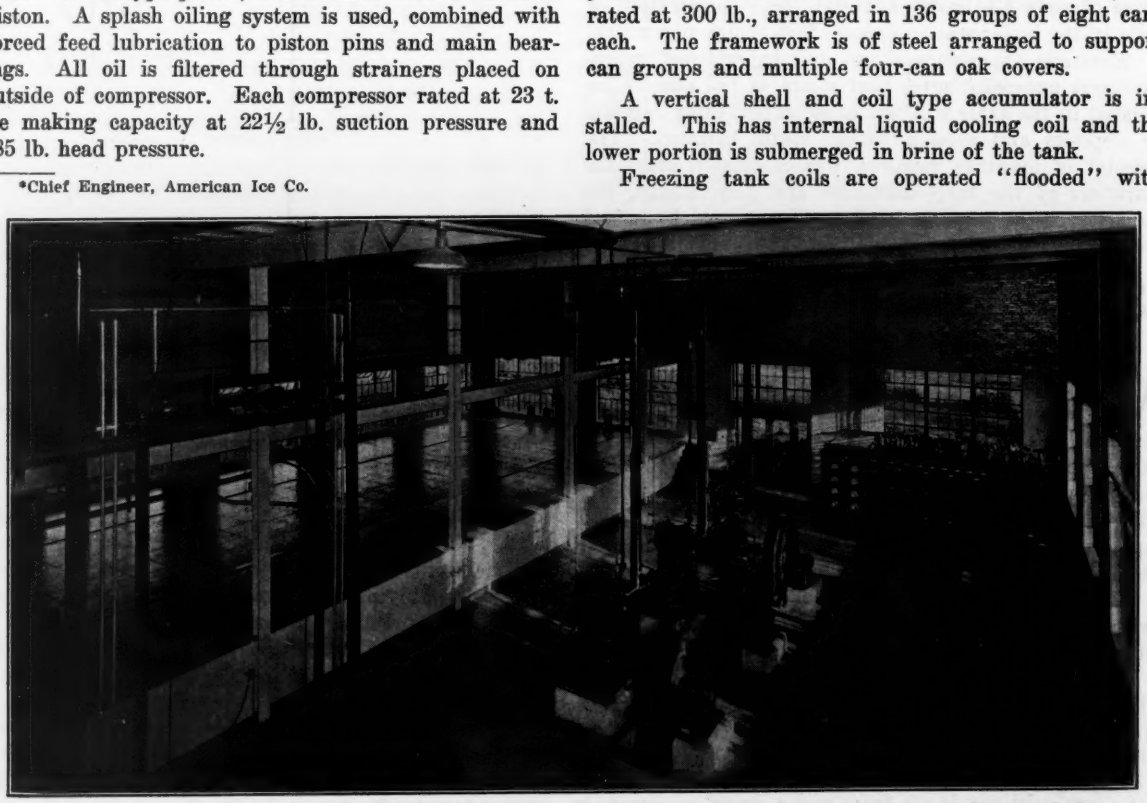


FIG. 1. GENERAL VIEW OF MACHINE ROOM SHOWING AMMONIA COMPRESSORS, SWITCHBOARD AND FREEZING TANK

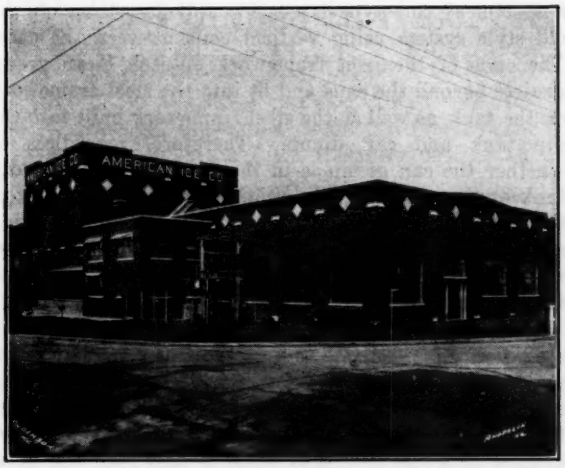


FIG. 2. PLANT NO. 3 OF THE AMERICAN ICE CO. AT KANSAS CITY

suction through the accumulator. All suction gas from storage rooms and fore-cooling tank is also brought through this accumulator. Four 15-in. vertical agitators are installed, each direct connected to 3-hp., 900-r.p.m. motors.

Air System

The air system is that generally known as high pressure air system. On this particular plant, however, two air pressures are maintained. Air at 30 lb. pressure is used to agitate the water in the cans for the first 45 min. of the freeze, but during the balance of the freezing time the water in the can is agitated with 18 lb. air. A dual header system is used to supply the air under these two different pressures so that the operation in changing from one pressure to another is very simple.

Compressed air is supplied by two horizontal air compressors, 12 by 10 in., of Pennsylvania manufacture, belted to 40-hp. motors. One air compressor is used as spare unit only and is also belted to a four-cylinder gasoline engine, so that it can be operated and carry the air on the tank in case of failure of the power.

An emergency air receiver, 42 in. in diameter by 11 ft. high, is provided. Galvanized air headers, piping, fittings and laterals used throughout. The dehydrating system is composed of duplicate shell and coil dehumidifiers used in connection with a galvanized air washer for properly cleaning and dehydrating the air used in agitating the water in ice cans. Brine is circulated by two centrifugal brine pumps, one for spare only.

All water used is treated by means of an International Filter Co. system, consisting of settling tank, duplicate pressure filters and duplicate circulating pumps. The water is treated with hydrated lime and alum only; soda ash is not required.

Miscellaneous

Besides the foregoing, the following are also installed:

Shepard two-point suspension three-motor traveling crane, for lifting the can groups.

Galvanized automatic eight-can filling tank. Balanced hydraulic operated can dump for handling of can groups.

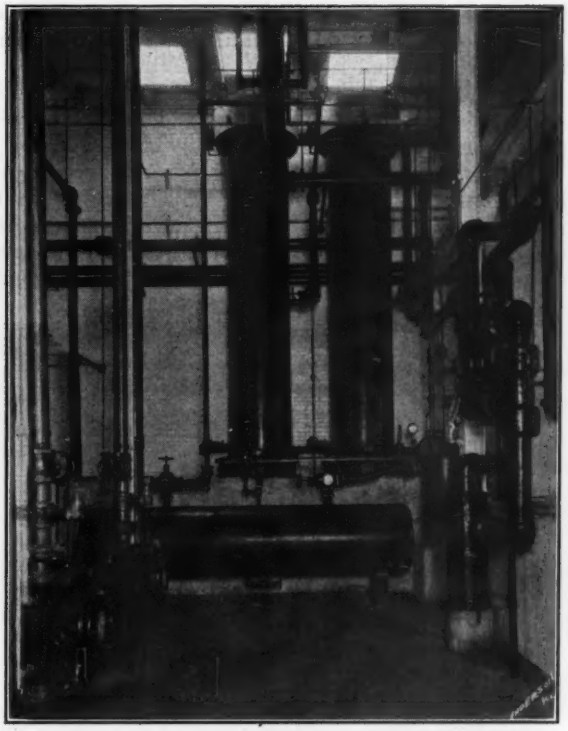


FIG. 3. SHELL AND TUBE AMMONIA CONDENSERS AND RECEIVER

Dip tank with warm water supplied from chamber around ammonia discharge line.

Galvanized fore-cooling tank containing direct expansion pipe for reducing the temperature of water to cans to 40 deg.

Authenreith core sucking unit, and individual core sucking and re-filling apparatus.

Two condenser water circulating pumps, direct connected to motors, each having a capacity of 600 g.p.m. One pump for spare only.

One pump for supplying water to air washer, having a capacity of 50 g.p.m.

Two exciter sets for ammonia compressor synchronous motors, one for spare only.

Two ice storage rooms, one for seasonal storage and the other for daily storage, are provided. These have capacities and dimensions as follows:

Seasonal—74 by 65 by 55 ft. high, having a capacity of 6000 t.

Daily—55 ft. by 76 ft. 6 in. by 8 ft. 10 in. high.

The piping for seasonal and daily storages consists of a total of 13,200 ft. of 2-in. ammonia pipe.

This plant is operated on 12-hr. shifts with a minimum of labor. Six men are used on the day shift, as follows:

Chief engineer, maintaining general supervision over plant.

Handy man for general all around work, such as cleaning condenser tubes, painting, etc.

Ice puller, to harvest ice and handle the general tank work.

Daily storage operator, to set up ice, place on dock and assist in loading of wagons and trucks.

Season storage operator to handle ice and elevators.

Scale operator on dock, selling retail ice and maintaining record of all ice sales.

Two men are used on the night shift. The night engineer assists in pulling cores and re-filling. Ice puller harvests ice and places in daily storage.

Four thousand volt current is purchased from the local power company, and is stepped down to 440 v. in transformers furnished by the plant owners. This current is used on the ammonia compressor synchronous motors and motors of all auxiliary apparatus. A

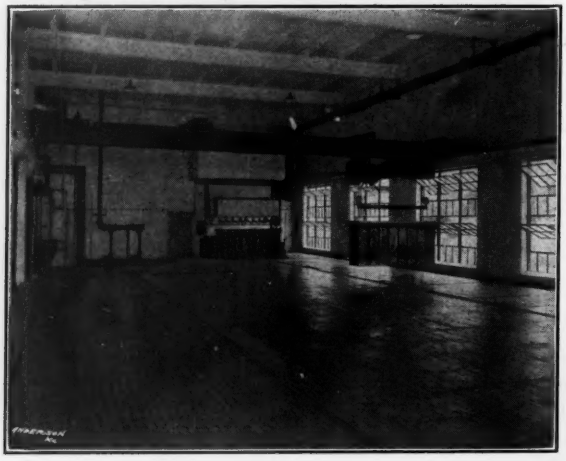


FIG. 4. A PHOTOGRAPH SHOWING THE TANK TOP AND AN EIGHT-CAN GROUP BEING CARRIED TO THE DIP TANK

separate transformer is used to supply 110-v. current for lighting purposes and for the motors on the Shepard crane. The main transformer station is located on the outside of the building.

Thermometers and gages are used throughout the plant on ammonia, water and air lines. For instance, thermometers are installed on suction and discharge lines of each ammonia compressor, on liquid ammonia line between condensers and receiver, on water lines to and from ammonia condensers and on high pressure air dehumidifying systems where necessary. Hourly readings of these thermometers are taken each day, so that it is possible to operate this plant at the maximum of efficiency at all times.

A spray pond system is used for cooling the condenser water, the makeup being supplied from the city mains. Four clusters of five nozzles each are used, placed on the roof of the engine room. Louvers are not required around the sprays due to the fact that the roof is exceptionally long and wide. The spray deck is constructed of seven-ply composition roofing material set in hot asphalt and made waterproof.

Armstrong Nonpareil Cork Covering is applied on all insulated lines. Two layers of 2-in. Armstrong Corkboard is used in both the season and daily storage rooms. The exposed surface of the second layer of cork applied in the daily storage is of the "Mastic Finish." The floor of the daily storage room is constructed of tongue and groove hard maple flooring.

The group freezing system was selected for this plant primarily because of the labor saving made in harvesting the ice and because the natural wear and tear on a system of this type is considerably less than on the old style system using vertical coils between the cans. The ends of the iron framework of each 8-can group project beyond the cans and fit into the steel framework on the tank, as well as the steel framework built into the dip tank and can dump. Therefore, regardless of whether the can group is in the freezing tank, the dip tank or the can dump its weight is carried by the steel framework so that the cans never touch bottom during any operation. The obvious result is that there is practically no depreciation in the ice cans as the ice puller cannot possibly handle the group roughly.

Flexibility in operation is obtained due to the installation of duplicate apparatus, such as air compressors, pumps, exciter sets, ammonia condensers and ammonia compressors. This is borne out by the fact that this plant has operated for approximately two years with a complete shut down of only fourteen days. This plant was shut down for eight consecutive days in December, 1925, and six consecutive days in 1926 for a general inspection and cleaning.

The following information was taken from the log sheets of the plant for the month of August, 1926, and

FIG. 5. REPRESENTATIVE CAKES OF ICE MANUFACTURED AT THE PLANT

briefly records the average essential pressures and temperatures of that period:

Condensing pressure—159.5 lb. (gage).
Suction pressure—27.2 lb. (gage).
Water to ammonia condensers—77.5 deg. F.
Water from ammonia condensers—81.7 deg. F.
Liquid ammonia temperature—81 deg. F.
Water to fore-cooler—83 deg. F.
Water to ice cans—44 deg. F.
Brine temperature—17.7 deg. F.
Daily storage temperature—25.6 deg. F.
Season storage temperature—25.7 deg. F.
Outside air temperature—79.6 deg.
Ice harvested per day—75.9 t.

This plant was designed and erected under the supervision of the York Products Corporation, St. Louis, Mo. The ice making and refrigerating equipment installed consists of all York equipment as manufactured by the York Manufacturing Co., of York, Pa.

Water Pumped to Reservoir Operates Hydro Plant

By Using Surplus Off-Peak Power to Pump Water to Reservoir, Rocky River Development Increases Peak Capacity of System

ON THE HOUSATONIC RIVER, the Connecticut Light and Power Co., which owns and operates several hydraulic plants, with others under consideration, has a unique development under way which will provide storage for most of these plants and will maintain their all-year capacity up to what is now the high water capacity. To accomplish this, however, the hydro plants will be shifted from the base of the load, where they will be used during high water, to the upper portions of the load curve and the steam plants used for the base load during low water periods. One very unusual feature of the new plant is that part of the water used in generating power will originally be pumped up into the reservoir through the very penstock through which it will later flow down again when the plant is generating.

This project, which is known as the Rocky River Development, consists of an earth dam across a basin near New Milford, Connecticut, located at an elevation of 200 ft. above the Housatonic River. The generating and pumping plant will be located on the river itself. The first installation in the generating station will be a unit rated at 30,000 kv.a. at 80 per cent p.f. In the same plant will be two large motor-driven pumping units, each motor having a rating of 8100 hp.

The drainage area of the Rocky River Basin will supply a part of the water used for power purposes. The balance will be supplied by pumping up from the Housatonic River at off-peak hours with existing equipment during high water periods. The efficiency obtained from this water is only 50 per cent; that is, from the water pumped only one kilowatt hour will be obtained from the plant for every two kilowatt hours consumed in pumping. Such a method of operating, however, is economically sound in this particular case, for several reasons. In the first place, the pumping is done off-peak, while the power will be generated during peak hours. Second, while the water is pumped against a head of 200 ft. and is utilized later by reversing itself and falling the same distance, it will also be further utilized through another fall of 200 ft. in plants now built or to be built by the company along the river between the Rocky River plant and tide water. This arrangement, according to the company, will make the plant in effect a huge storage battery with 100 per cent efficiency, without counting the water from the drainage from the Rocky River basin itself which will supply approximately one-half of the total amount used.

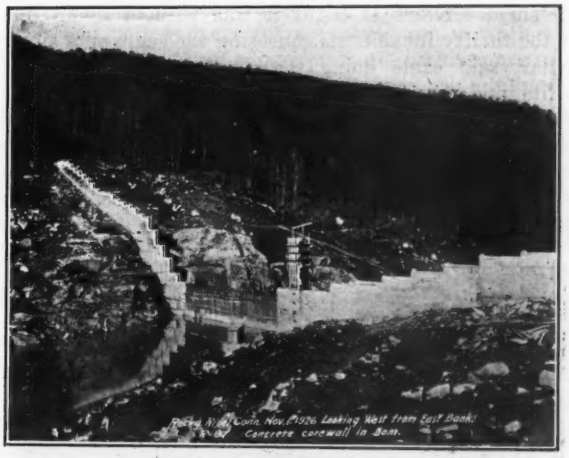


FIG. 1. VIEW OF ROCKY RIVER DEVELOPMENT IN NOVEMBER, 1926, SHOWING COREWALL OF MAIN DAM

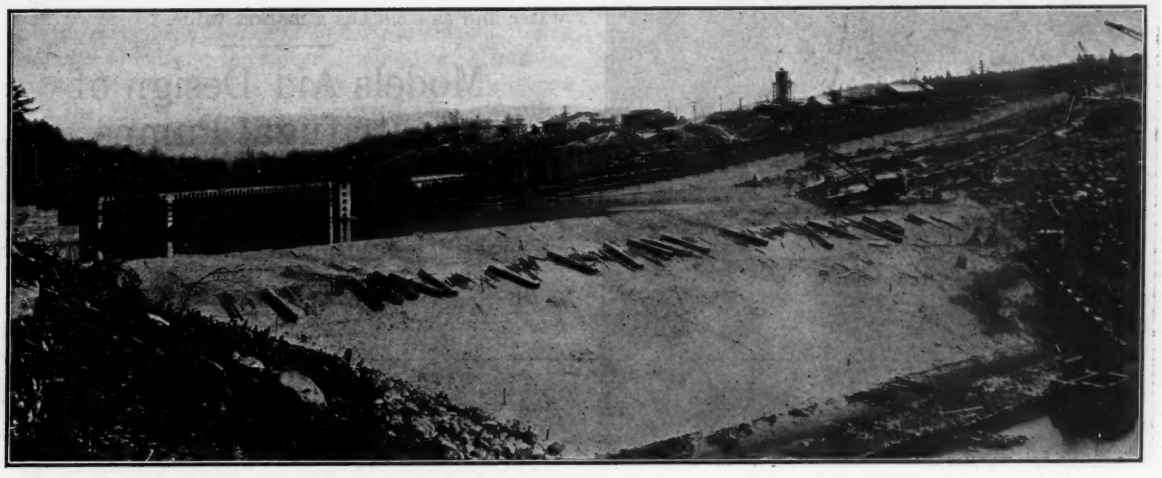


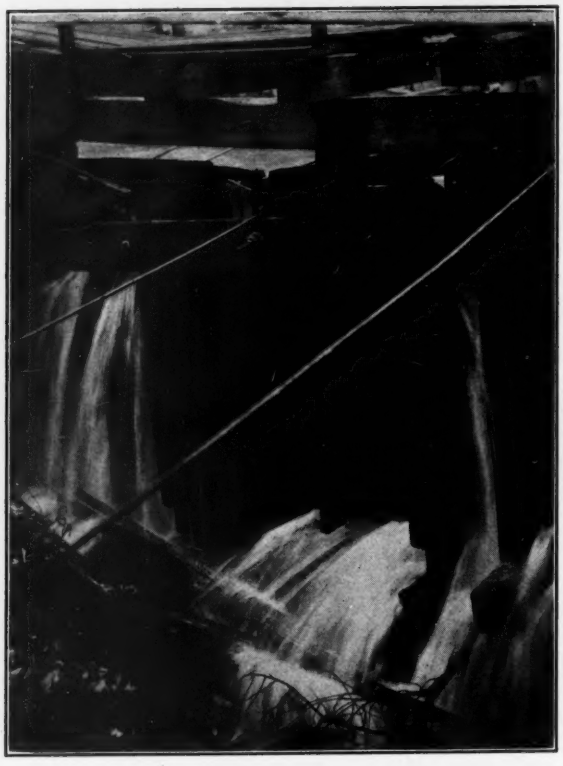
FIG. 2. VIEW OF ROCKY RIVER DAM TAKEN IN MAY, 1927, SHOWING EARTH FILL DAM BUILT BY FULL HYDRAULIC SLUICING METHOD

The Philadelphia Electric Co., Philadelphia, Pa., Pennsylvania Power & Light Co., Allentown, Pa., and the Public Service Electric & Gas Co., Newark, N. J., have concluded arrangements for a pooling of interests for exchange of power. When completed, the interconnected systems will have a combined capacity of 2,250,000 kw. New transmission lines and switching stations will be constructed for this purpose.

A Hot Tale in Cold Cash

WHERE MONEY SAVED MEANS WATER LOST. BY JOHN S. CARPENTER

IT IS said of a certain county that if you heard shrill screams at night it was without doubt one of the thrifty inhabitants squeezing the eagle on a silver dollar, said eagle doing the screaming. By way of polite and formal introduction, I will say that the above-mentioned county was not the one in which the attached photograph was taken. The picture shows part of a wooden penstock carrying water from the dam to a water turbine, the length of the penstock being about 1500 ft. In an experience of nearly 20 yr. in the water



PARTIAL FLOW DIAGRAM OF PENSTOCK EFFICIENCY

power business, I declare the owners of this plant to be prize winners, the prize being celluloid grate bars for the boiler plant they run to make up for the deficiency in power of the water turbines.

At first I could hardly believe that power plant owners would allow such a condition to exist, but here it is; see for yourself. And the sad part of it is that there are other plants dotting the country in similar, but not so chronic, a condition. The total leakage in this penstock amounts to about 73 hp. at the turbine shaft or approximately 50 kw. continuously day and night. In this particular locality, current costs about 3c. per kw-hr. in such amounts, at the switchboard. A little figuring with a pencil and paper shows that the value of the wasted power going to blazes in this messy way amounts to just $13,140 per year and if the current rate of interest is 6 per cent, this tidy little sum would pay the cost of the annual use of about $219,000. The sum of $13,140 would not quite pay the cost of rebuilding the whole penstock and incidental expenses but the savings over a period of 20 mos. would do it at this rate.

In the same way the use of obsolete water turbines can be shown to be extremely wasteful, although the fact is not so plain to the eye of the merest layman. In these days when turbines having efficiencies of 90 per cent and better can readily be bought, it is plain that the use of older turbines that had an efficiency of perhaps 80 per cent when new, such efficiencies being considered quite good 10 and 15 yr. ago, is certainly a doubtful economy. The old turbine has probably depreciated some 10 per cent in efficiency to date, so what we are comparing is a 70 per cent turbine with a 90 per cent turbine. The way things are usually found is that the streams are commonly developed to their full capacity and the old turbine would require power from an outside source in order to make up for the loss. That means purchased power or perhaps an oil engine and generator set installed to make up the deficiency.

Any concern with any standing at all should have little trouble in showing a conservative banker what could be reclaimed by rebuilding and buying new machinery to eliminate such frightful water waste, which, although merely water, is certainly energized water and as such has a market value.

Models Aid Design of Centrifugal Pumps

WHEN THE CITY OF DETROIT, Michigan, ordered two new 36-in. motor-driven centrifugal pumps for its No. 1 waterworks pumping station, it was specified that one pump was to deliver 50 million gallons

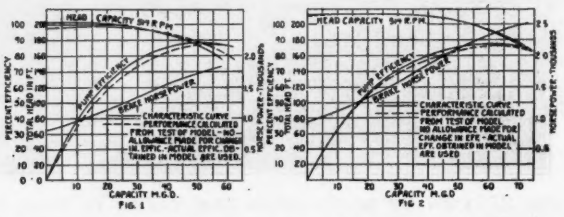

HEAD
CAPACITY
R.P.M.
PUMP EFFICIENCY
BRAKE HORSE POWER
CHARACTERISTIC CURVE — PERFORMANCE CALCULATED FROM TEST OF MODEL — NO ALLOWANCE MADE FOR CHANGE IN EFFIC. ACTUAL EFFIC. OBTAINED IN MODEL ARE USED.
CAPACITY M.G.D.
FIG. 1
HEAD
CAPACITY
R.P.M.
PUMP EFFICIENCY
BRAKE HORSE POWER
CHARACTERISTIC CURVE — PERFORMANCE CALCULATED FROM TEST OF MODEL NO ALLOWANCE MADE FOR CHANGE IN EFFE — ACTUAL EFF. OBTAINED IN MODEL ARE USED
CAPACITY M.G.D.
FIG. 2

FIG. 1. COMPARISON OF CHARACTERISTICS OF 50-M.G.D. PUMP WITH THOSE CALCULATED FROM MODEL

FIG. 2. COMPARISON OF CHARACTERISTICS OF 70-M.G.D. PUMP WITH THOSE CALCULATED FROM MODEL

of water a day and the other 70 million gallons a day, against 170 ft. head, that the casings of the pumps were to be the same and that they were to be designed so that the smaller pump could be converted later to a capacity of 70 m.g.d. with no change except the impeller.

Contract for these pumps, to be driven by General Electric synchronous motors, was awarded to the Worthington Pump & Machinery Corp. of New York, which decided to develop the design of the pumps by the use of models, as is done with hydraulic turbines. This was done successfully and the recent tests of the full size units compare very closely with the expected performance as calculated from the models. This comparison is shown in Figs. 1 and 2.

Besides this, the units had to be designed for an overall combined efficiency of pump and motor of 80 per cent, with a bonus and penalty clause in the contract. As shown in Figs. 1 and 2, this combined maximum efficiency is 84.7 per cent for the 150-m.g.d. unit and a pump efficiency of 88.5 per cent. For the 70-m.g.d. unit, the combined maximum efficiency was 82.7 per cent and pump efficiency 86 per cent. It is stated that this is a world's record.

Slagging Difficulties Being Reduced

INFORMATION on certain phases of stoker operation has been collected by the N. E. L. A. and deals largely with furnace and furnace construction being used to allow high rating stoker installation.

For hand-fired furnaces it was in some cases customary to keep a shallow ash pan flooded with water so that heat radiated from the grate caused evaporation tending to saturate the combustion air. Experience indicated that this moisture was of real benefit in reducing clinkering on the grates. Steam has been and is being used occasionally to prevent excessive clinker formation, but as yet there has been no fixed rule formulated for its application.

With early installations of underfeed stokers, it was customary to exhaust the stoker driving engine into the ash pit. Frequently this exhaust steam was delivered under the grates through a perforated pipe extending the full width of the ash pit. The presence of this steam was believed to be of material benefit in both the cooling of the grates and reducing the clinker trouble. Small turbine-driven blowers were commonly backed by claims of clinker reduction because of the steam being exhausted directly into the ash pit in this manner.

Following the development of the underfeed type of stoker, a number of schemes were tried for preventing the adhesion of clinker to the side and bridge walls. Among these was one by the admission of steam through a perforated pipe made along the edge of the grate to the side walls. This practice is generally reported as being beneficial.

In a number of cases, one stoker manufacturer introduced a small quantity of water at the lower end of the grate in an underfeed stoker. This water, on evaporation, reduced clinker formation in the fuel bed at this point. Another stoker generally uses exhaust steam through the rear transverse bar along the space of the bridge walls in order to keep down the clinker formation which tends to build up over the grate.

Use of live steam was found to be too expensive except in extreme cases, while improvements in stoker design, the use of perforated air backs, air cooled blocks and carborundum refractories has practically eliminated the use of steam to prevent clinker formation on furnace walls.

Carborundum refractories are now being used extensively to cover the clinker zones along the front, side and bridge walls, the clinker pits of stoker-fired furnaces burning bituminous coal and along the side walls of traveling grate stokers burning anthracite. These refractories are made in a great variety of shapes so that it is possible to obtain them in any form similar to the clay product being used in furnace construction.

Solid carborundum blocks without air cooling, of the standard 9 by 2.5 by 4.25 in. size, are usually used along the side walls with traveling grates burning anthracite. Carborundum blocks 9 by 7⅝ by 7 in., designed with solid and hollow backs for air ventilation or with perforated fronts for air admission to the furnace are used with all makes of furnace when burning bituminous coal. In some furnaces burning bituminous coal where air ventilated or perforated carborundum blocks are used, designers are including several courses of solid 9 by 2.5 by 4.5-in. brick above the carborundum blocks in the slag zone.

Ten operating companies reported the use of carborundum refractory and stated that they found that the clinker does not adhere as tightly to this material as to clay. The clinker is easily removed, thus reducing the time and labor required. Solid carborundum blocks along the side walls of furnaces burning anthracite coal are, in all cases, reported as being subject to very low maintenance cost with an average life as reported by one company of 4 yr.

Several companies report high maintenance cost on the carborundum ventilated and perforated blocks because of the large amount of breakage due to mechanical failure. After these blocks have been subjected to furnace temperatures or shock such as that resulting from the removal of clinkers, the face often cracks. Stresses caused by expansion and contraction of the furnace walls also seem to result in breakage but in most cases operators report beneficial results which warrant the continued use of carborundum instead of clay.

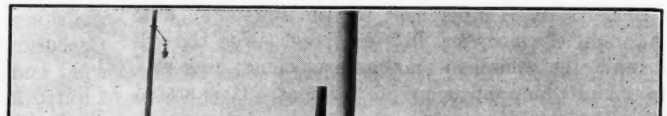
Life of Blocks Depends upon Their Location in the Furnace

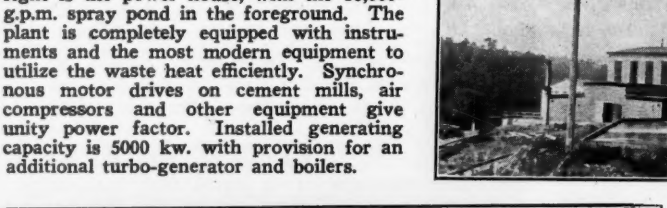
General results which may be expected are reported by one company as follows: "The life and stability of carborundum blocks and bricks depends largely on their location in the furnace wall. In our oldest installations, 2 or 3 yr. service, the bridge walls are still in good condition without replacement. Blocks are frequently found to be cracked across the face and fractured between the solid front and hollow rear section, but in the bridge wall and front wall these broken blocks remain in place and do not require replacement. The blocks in the side walls are subject to the hardest service because of the daily removal of clinkers. Resetting the blocks is required at irregular intervals from 3 mo. to 3 yr. in some instances. At some times replacement of broken blocks is necessary. This replacement varies from 0 to 30 per cent of the total number installed."

Considerable progress has been made during the past year toward the solution of the problem of field balancing of turbo-generators. A vibrometer has been developed by one company and, by means of it, amplitudes of vibrations and their directions are quickly determined so that the balancing operation is greatly facilitated. By means of this instrument it has been found possible to plot curves of amplitude and foundation vibration, showing the effect of various corrective measures and, by its use, improve the running of the machine.

Sandt's Eddy Cement Mill Makes Power from Waste Heat

WASTE HEAT in the flue gas from the cement kilns generates steam from which the new Sandt's Eddy, (Penna.) plant of the Lehigh Portland Cement Co. makes all the electric power for its cement-manufacturing processes. At the right is the power house, with the 10,000-g.p.m. spray pond in the foreground. The plant is completely equipped with instruments and the most modern equipment to utilize the waste heat efficiently. Synchronous motor drives on cement mills, air compressors and other equipment give unity power factor. Installed generating capacity is 5000 kw. with provision for an additional turbo-generator and boilers.





At the left are the two 2500-kw., 3600-r.p.m. turbines, taking steam at 175 lb. gage, 100 deg. superheat and each driving a 3125-kv.a., 2300-v. generator with direct connected exciter and generator air cooler. These turbines exhaust into 3500-sq. ft. surface condensers, shown below with their steam jet air pumps, circulating pumps and other auxiliaries.

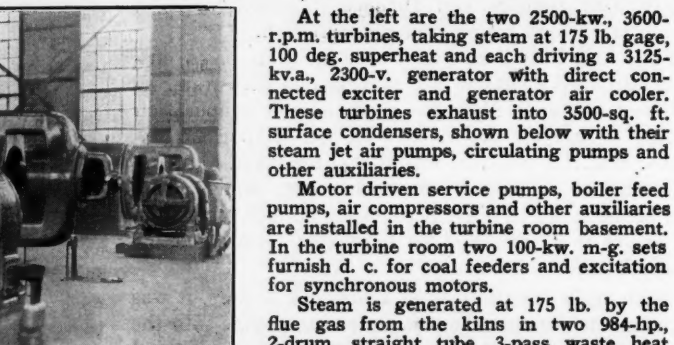
Motor driven service pumps, boiler feed pumps, air compressors and other auxiliaries are installed in the turbine room basement. In the turbine room two 100-kw. m-g. sets furnish d. c. for coal feeders and excitation for synchronous motors.

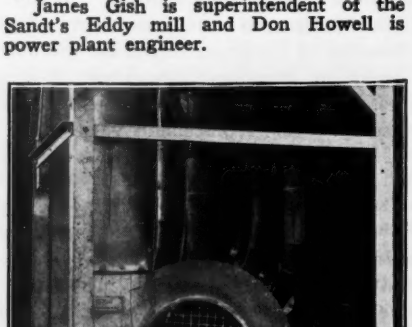
Steam is generated at 175 lb. by the flue gas from the kilns in two 984-hp., 2-drum, straight tube, 3-pass waste heat boilers, equipped with cast iron economizers, superheaters and induced draft fans.

Dust from the flue gas drops to ash hoppers in the furnace bottoms from which it is taken by screw conveyors, mixed with water and sent to the slurry tanks. Feed water is heated in an 1800-hp. open feed water heater. Boilers and economizers are equipped with soot blowers; platforms are hoisted up and down beside the boilers, to give access instead of ladders.

Below at the left is shown an auxiliary 500-hp., V-type, water tube boiler used for starting up or standby. This can be fired with either pulverized coal or fuel oil. At the right are shown three 4-t. screen type mills which pulverize coal for the cement kilns and for the auxiliary boiler. In the left foreground of this view is shown a 5½ by 42-ft. rotary coal dryer.

James Gish is superintendent of the Sandt's Eddy mill and Don Howell is power plant engineer.





Efficiency, Keynote of National Fuels Meeting

OUR NATURAL FUEL RESOURCES FROM THE MINES OR OIL FIELDS THROUGH TO THE PRODUCTS OF COMBUSTION DISCUSSED BY THOSE INTERESTED FROM A FINANCIAL AND CONSERVATION STANDPOINT, BOTH IN RELATION TO OUR PRESENT NEEDS AND TO POSTERITY

PRODUCTION, distribution and utilization of our natural fuel resources was discussed in detail at the first fuel meeting held under the auspices of the Fuel Division of the A. S. M. E. at St. Louis, October 10 to 13. The Fuel Division was formed as a "centralized agency for the development and dissemination of sound information and proper and efficient use of fuel." The purpose of this meeting, as stated by the committee, is based upon the realization "that it is essential, if the problem of fuels is to be properly taken care of, that all engineers, regardless of society membership, technical as well as practical, be put in contact with one another."

Naturally coal and coal products received major consideration although liquid and gaseous fuels were discussed in considerable detail in many of the papers. In fact, Professor Parr in his opening address, following the welcome from a spokesman of Mayor Victor J. Miller of St. Louis, stated that "Let it be noted finally that the ideal fuel as a heating medium is gas. Its smokeless combustion, high efficiency, cleanliness and convenience give it a status unapproached by any other type of fuel. When it reaches the stage of volume production to an extent where costs can be materially reduced, the extension of its use will be greater than can be remotely realized at the present time. . . . Possibilities now emerging furnish a most encouraging outlook whose reduction to everyday industrial and living conditions we shall certainly see consummated in the early years of a new fuel century now before us."

END OF ANTHRACITE IS IN SIGHT

That fuel reserves available at the present economic level are much less than are generally believed, was pointd out by O. P. Hood, who went on to point out the growing appreciation of the value of fuel, giving estimates of liquid, gaseous and solid fuel resources, their increasing rate of consumption and the possibilities of using the lower grades of coal down to the lignites and peats. He warned that natural gas has come and gone in many of our communities, our finest coking coal districts are depleted and the passing of anthracite is in sight.

Efficiency through proper application and design of furnaces and more efficient processes is, of course, the only solution of the problem. Combustion and heat transfer, particularly with reference to radiation from suspended particles in a pulverized coal flame, from non-luminous gases and luminous gas flames were discussed by Professor R. T. Haslan and H. C. Hottel. Principles brought out in the first part of this paper were later applied to furnace design as the basis of rational equations to assist in the solution of furnace problems. Following the presentation of this paper, H. D. Savage brought out the economic and conservation advantages of low temperature coal carbonization and told something of the new plant to be built in conjunction with the new plant of the Public Service Company of Newark. Low temperature carbonization, he feels, is destined to be of greater economic and engineering importance than pulverized coal.

At present it is not economical in many industries to save fuel. Examples of the steel industry, gas industry, power plant and domestic dwelling, given by Professor W. Trinks, show that the labor and investment cost of fuel saving equipment is often financially impractical with our present price of fuel. He advocates again, as in 1918, a high state or federal tax to put an artificial value on fuel in order to make conservation methods financially profitable and to conserve coal for posterity.

Efficient utilization of fuel involves high temperature and in turn imposes severe conditions on refractories. This angle was discussed by Stewart Phelps, particularly with reference to boiler settings of normal design from a standpoint of the strength of refractory, confinement of heat, resistance to destruction, melting, slagging and spalling.

PULVERIZED COAL SATISFACTORY FOR SMALL INSTALLATIONS

Because of the wide application of water walls in larger furnaces, the subject of refractories is possibly of more interest to the smaller industrial installations, many of which are considering installing pulverized coal firing. Although pulverized coal offers advantages to many of these smaller industrial boiler installations, there are certain limitations in design and application which make the small plant unable to attain a high efficiency, and in some cases impractical. Actual application of pulverized coal firing to industrial plants were related and described by Henry Kreisinger, who pointed out the advantages and limitations of each.

Clinkering of coal ash is another subject of great importance, particularly in relation to the lower grades of coal. A. C. Fieldner, W. A. Selvig and P. Nicholls reported on tests of 21 coals, ranging in ash fusibility from 1990 to 2930 deg. F., as to composition, distribution and fusibility of ash. They found that under certain conditions the quantity of clinker decreases as the rate of burning increases, that it has a fairly definite relation to the softening temperature of the coal ash, that this relation becomes more consistent as the size of the coal decreases, and that washed coal causes a reduction in clinker formation greater than that due to the proportion of inorganic matter removed by the washing process.

EXPERTS DO NOT ALWAYS AGREE

Descriptions of the well type furnaces and test results at Charles R. Huntley Station by H. M. Cushing and R. P. Moore, and consideration of the factors governing the purchase of fuel by Morgan M. Smith are covered in more detail elsewhere in this issue. The former paper was the subject of lively discussion, leaving little doubt that furnace design is still in an unsettled condition and that experts, even in engineering, do not always agree. Although fuels and furnaces are

the most important factors in the conservation of fuel, boilers cannot be overlooked. E. R. Fish traced the development of boilers, from the early installations of small capacity up to the modern high pressure types, describing methods of construction and equipment tending to increase efficiency in some detail.

At the industrial session held simultaneously with the power plant session on October 12, progress in gas producer design, use of fuels in brick kilns and the burning of liquid fuel were considered in three separate papers. W. B. Chapman traced the development of gas producers and gave reason for the adoption of improvements. Firing methods peculiar to the brick kiln operation were discussed by W. E. Rice, who described firing processes and limitations imposed on combustion engineers, pointing out many of the faults often found, corrections that may be applied and the possibilities of future improvements. Oil reserves, oil shale deposits and the production of synthetic fuels were discussed by Ernest H. Peabody, who further encouraged economy in the burning of all liquid fuels, telling of some of the steps that have been taken and equipment developed to accomplish this.

During the power plant session, F. H. Daniels pointed out the characteristics demanded of modern stokers and the way in which these requirements are met by traveling-grate and multiple-retort underfeed types. Discussion brought out corresponding characteristics of the chain grate type, showing the two types to be about equal when considered in relation to conditions for which they are adapted. Air preheaters were described by Frank M. Van Deventer, who outlined the several chronological steps of development which led to the air heater, and included a brief description of the principal types now available. Methods of procedure for selecting a heater were proposed and an outline given of the conditions affecting the selection, and an outline of the economic solution of the problem. The importance and correct design of control equipment were stressed in a paper entitled "Automatic Combustion Control," by T. A. Peebles.

Coal Preparation Is Receiving Much Attention

Description of a modern mine and preparation plant were given by William Beury at the last general session. He outlined conditions encountered by miners, methods employed to produce a coal of the maximum quality and the quality of coal from the standpoint of preparation, that is, sizing and cleaning. Proper coal preparation is becoming of increased importance where both efficiency and maintenance are considered. Economies of dry-quenching coke by the Sulzer process were discussed by A. M. Beebee, who gave some costs and compared this with other types of plants from the standpoint of ease of operation, quality of the product and labor required, particularly in relation to experiences with the installation of the Rochester Gas & Electric Corp.

Smoke abatement, being a subject which is of vital importance to the entire community, from a health and nuisance standpoint, as well as of interest to the engineer from the standpoint of inefficiency, was made the subject of the entire discussion on October 13. The subject was opened by J. B. Irwin, who discussed the subject from the standpoint of the railroad and outlined prevention programs being carried out in various railroad terminals. This paper was followed by "The Measurement of Atmospheric Smoke Pollution, Visible and Invisible," by Dr. George T. Moore; "Smoke-Abatement Methods Used in Cleveland," by Col. Elliott H. Whitlock; "Managing a Smoke-Abatement Campaign," by Erle Ormsby; and "The Effect of Atmospheric Smoke Pollution—A Summary of Opinions from Current Literature," by Prof. A. S. Langsdorf.

Smokeless and efficient firing of domestic furnaces was covered by Victor J. Azbe, who presented data from tests conducted over a period of 2 yr. on the firing of domestic furnaces. He outlined a new method of practically smokeless firing with good efficiency. This can be accomplished by slight changes of furnace design and can be applied to existing installations.

Many inspection trips were arranged to Cahokia station and industrial installations. A smoker the evening of October 10 was followed by a banquet the evening of October 11, and a simultaneous meeting at the Engineers' Club and demonstration at the firing school the evening of October 12. This firing school is maintained by the Smoke Abatement League for the free instruction of firemen and janitors.

Approximately 700 registered. The meeting was one of the most cosmopolitan ever held; practically all societies and all industries were represented, certainly a remarkable demonstration of the importance and appreciation of the value of fuel.

Goggle Alibis

(1) "They hurt my eyes. They give me a headache." Examination by oculist will determine whether or not there is defective vision. If so, he should be provided with prescriptive lenses.

(2) "They 'fog-up' and I can't see through them." Rub both sides of lenses with a piece of Ivory soap, wipe with dry cloth. This will prevent fogging for several hours.

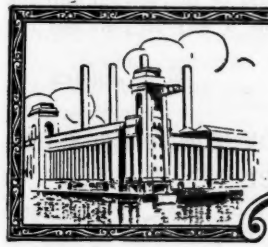
(3) "They make me look funny." Better look funny with two eyes than pathetic with one.

(4) "Goggles are heavy." The fact is they weigh about 1½ oz., very little more than an ordinary pair of glasses. There is no comparison between the weight and the protection they offer. Better suffer temporary inconvenience than permanent loss of vision.

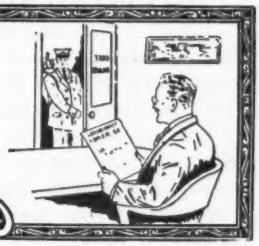
(5) "Why should I wear them? There are men in other departments who never wear goggles." Granted that a man chipping a casting is exposed to a greater hazard than a man at a wood machine. The fact remains that scores of men in wood working plants have lost eyes as a result of being struck by slivers of wood.

These constitute a few of the objections raised by men, none of them, of course, being logical and they can all be smoothed out by individual talks and personal interest upon the part of the Safety man.

While a great deal of difficulty is experienced in persuading men with two eyes to wear goggles, I have yet to learn of a case where a man with one eye objected to protecting his remaining orb. This, I feel, bears out my contention that goggles are absolutely practicable and can be worn by anyone, irrespective of his occupation.—H. Guilbert, Nat'l Safety Council.



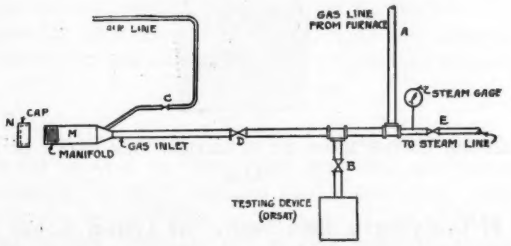
LETTERS DIRECT FROM THE PLANT



Piping Connections for Sampling Flue Gas

COMBUSTION conditions in a furnace may be readily determined by proper gas analysis but owing to the high temperatures within the furnace, it is difficult to keep the gas lines clear. Fusing of the line at its entrance to the furnace can be prevented in several ways. It is usually accomplished through use of double pipes, special pipes or protective surroundings, but the line tends to clog up and the frequent cleaning usually required involves considerable work.

This pipe can be kept clear through the use of air or steam. The air may also be used as in an ejector in which case greater quantities and better quality of gas may be secured for sampling and the time interval between the entrance to the sampling tube and the CO_2 reading, reduced. The method used is shown in accompanying illustration where A represents a pipe line



ARRANGEMENT PERMITS BLOWING OUT GAS SAMPLING LINE BY AIR OR STEAM

through which furnace gases are brought to the testing device X. A valve B permits connection with testing device when desired. Air is brought to the manifold M through an air line fitted with a valve C which is used to shut off connection when not in use. Valve D is used for drawing gases or admitting air and valve E for admitting steam when desired. Manifold M has a threaded end which is fitted with a cap.

When it is desired to take a reading, valve B is closed to the instrument, valve D is opened to the manifold and valve C is opened to admit air which in blowing through the manifold acts as a siphon drawing gases from the boiler. When the air is on for a sufficient length of time to secure a good sample of gas, the gas valve D is closed, the air turned off and the valve B opened to admit the gases to the testing instrument.

When the gas line becomes dirty it may be cleaned by screwing the cap N on manifold, closing valve B, opening valve D and admitting air through valve C into the line to the furnace tap. This cleaning may also be accomplished through the use of steam by closing valves B and D at which time steam is admitted through valve E and the condition of the pipe indicated by means of the pressure gage.

Aurora, Ill. E. J. MORRISSEY.

Designation of Pulverized Coal Sizes

RESULTS OF TESTS with pulverized coal on page 971 of the Sept. 15 issue were read with interest. What interested me most was that the tests were made on old-

TABLE SHOWING RELATION BETWEEN SIEVE OPENING AND SIZE OF WIRE FOR DIFFERENT DISTINGUISHING SIEVE NUMBERS

Sieve Number	Opening		Wire Dia.	
	MM	Inch	MM	Inch
4	4.76	.187	1.27	.050
5	4.00	.157	1.12	.044
6	3.36	.132	1.02	.040
7	2.83	.111	.92	.036
8	2.38	.0937	.84	.0331
10	2.00	.0787	.76	.0299
12	1.68	.0661	.69	.0272
14	1.41	.0555	.61	.0240
16	1.19	.0469	.54	.0213
18	1.00	.0394	.48	.0189
*20	.84	.0331	.42	.0165
25	.71	.0280	.37	.0146
30	.59	.0232	.33	.0130
35	.50	.0197	.29	.0114
40	.42	.0165	.25	.0098
45	.35	.0138	.22	.0087
50	.297	.0117	.188	.0074
60	.250	.0098	.162	.0064
70	.210	.0083	.140	.0055
80	.177	.0070	.119	.0047
100	.149	.0059	.102	.0040
120	.125	.0049	.086	.0034
140	.105	.0041	.074	.0029
170	.088	.0035	.063	.0025
200	.074	.0029	.053	.0021
230	.062	.0024	.046	.0018
270	.053	.0021	.041	.0016
*325	.044	.0017	.036	.0014

fashioned screens designated by mesh, namely, 40 mesh, 60 mesh, 80 mesh, etc.

It has been decided by scientists that designation by mesh is not satisfactory. For example, 100 mesh means 100 meshes to the inch, measuring from center to center of wires, but the wires could be of any diameter from 0.003 to 0.0045 in., each variation of size in this range making the spaces between wires smaller. It is readily apparent that a much coarser coal particle could pass through a 100-mesh sieve made from 0.003-in. diameter wire than could through a 100-mesh sieve made from 0.0045-in. diameter wire.

The new method of designating by number as recommended by the U. S. Bureau of Standards, eliminates any possibility of misunderstandings. In the new series of testing sieves, as specified by the U. S. Bureau of Standards, the capacities of the sieve vary in a gradual, uniform manner, permitting a selection from this series for practically every purpose.

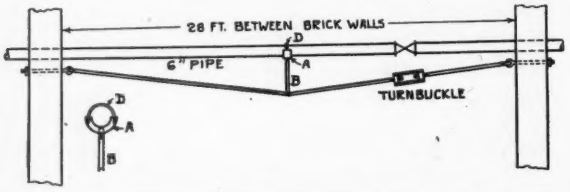
The accompanying table shows how carefully this matter of sieves has been worked out.

Newark, N. J. W. F. SCHAPHORST.

Truss Forms Convenient Pipe Support

WHEN I was employed at the Ontario Government Hospital at London, Ont., there was an unsupported run of 6-in. pipe 28 ft. long between two brick walls. The pipe was supported on the outer sides of the walls by hangers, not shown, which were supplied with pipe rollers. Conditions were such that it was not feasible to support the pipe in the center from standards below or hangers above, so the truss shown was used and with success.

Eye bolts through the walls were used as shown. A heavy iron piece, A, was forged and the rod, B, screwed



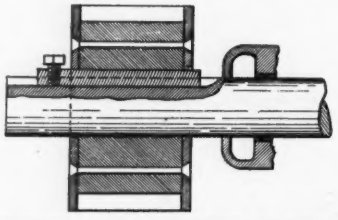
ADJUSTABLE SUPPORT WHICH REQUIRES NO POST NOR OVERHEAD CONNECTION, SECURED BY MEANS OF TRUSS CONSTRUCTION

into it. The bottom of the rod was grooved, as shown at C, to fit over the truss rod. A half circle of ½-in. rod, D, was used over the pipe, the ends fitting in holes drilled into R. After everything was assembled, as steam was turned on through the pipe, the turnbuckle was tightened up. The rod, D, acted merely as a safety device to hold B in case it should be accidentally struck at any time.

Toronto, Canada. JAMES NOBLE.

Kink Makes Key Removal a Simple Matter

WHEN SECURED by a key, removing a pulley or gear wheel from a motor shaft is often a difficult matter.



SET SCREW THROUGH KEY PREVENTS IT FROM LOOSENING

The key must be a good fit on its sides and to prevent it from working out it must also fit at the top and bottom.

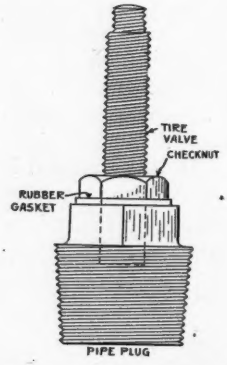
It is this requirement of fitting all over that increases the difficulty of fitting and withdrawing. A plan that I have used is to make the key a good sliding fit on its sides and quite slack top and bottom. Near the outer end of the key a hole, as large as the width of the key will allow, is drilled and tapped to receive a set screw as shown in the illustration. With pulley or gear wheel in position, the key is white-leaded and slid in. The set screw is then tightened securely.

To remove the key, all that is generally necessary is to loosen the set screw, but if the key should be set with rust or dirt, kerosene should be introduced and the tapped hole in the end suggests a way to pull out the key.

Long Beach, Calif. E. J. JORDAN.

Pipe Plug Forms Convenient Pressure Tester

TANKS and piping jobs may be tested for leaks and loose joints before the job is put into service by the use of the simple device illustrated herewith, which can be used in connection with an ordinary tire pressure pump. A $\frac{13}{32}$-in. hole is drilled through the center of a standard pipe plug and a tire valve salvaged from an old tube is inserted. Part of the rubber is left around the valve to act as a gasket. The valve is drawn up tight with the check nut on top of the plug. The plug can be inserted in any convenient part of the line by providing a fitting, such as a tee, which has a side outlet. By means of the air pump, pressure, indicated by a regulation pressure gage, can be applied to the system.



PRESSURE TESTER MADE BY INSERTING TIRE VALVE IN PIPE PLUG

If this plug is used before the system is put into service, a great deal of time may be saved in repairing any leaky joints, especially if the system has to be drained before the leaks can be stopped. This simple device takes up little room in the kit and can be used for any pressure up to 80 lb. It will quickly reveal any leaky joints.

Syracuse, N. Y. H. L. WHEELER.

Too Many Warnings

TOO MANY rules and regulations, many of them obsolete, will neutralize the purpose which they were originally intended to serve. Particularly does this apply to safety warnings and danger signs.

Not long ago we visited a large plant that seemed literally plastered with red, glaring "Danger" signs. It was apparent that, in some places, these signs were needed. At other places there seemed little or no danger and the presence of such signs tended to make all such warnings mere fixtures on the walls.

Managers should do everything possible to make equipment and methods as nearly foolproof as possible. Guards and safety devices should always be installed at the time a machine is installed, then kept in a state of good repair but the posting of warning signals or the

creation of rigid safety rules where neither is needed will nullify the good effect of such warnings and rules where they are necessary.

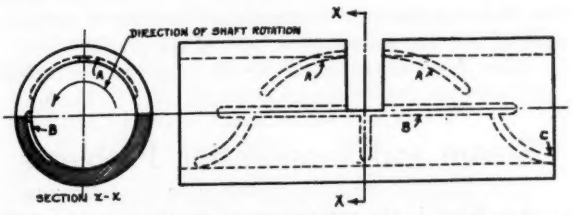
In some employes, timidity and fear may be created by warnings, and fear is known to be a fruitful source of accident.

Elimination of every unnecessary safety rule and of all but the vitally important danger signs will, if coupled with constant educational effort, do more to reduce accidents and develop respect for necessary rules than anything else. The educational effort rests largely with the foremen and department heads.

Chicago, Ill. WILLIAM SIBLEY.

Wrongly Made Oil Grooves Cause Trouble

THE BABBIT bearing on the thrust side of a high speed pump heated to such extent that it was decided to take it out and investigate the cause; the oil supply being kept to an ample height and the ring working freely.



VIEWS OF BEARING BUSHING SHOWING AT A THE ORIGINAL OIL GROOVES WHICH WERE CUT AT THE TOP; AT B THE NEW OIL GROOVES WHICH WERE CUT ON ONE SIDE; AND AT C HOW THE OIL GROOVE NEXT TO THE THRUST BEARING WAS CUT THROUGH

Trouble came from the oil grooves which were made as shown at A in illustration herewith; not enough oil reaching the thrust side for good lubrication. A groove was cut in the babbit, at the edge of the oil ring opening on the "running in" side to carry oil through to the thrust side as shown at B and it overcame the heating.

Clarkdale, Ariz. CHAS. LABBE.

Driving Pipe Avoids Road Cutting

DURING the remodelling of a small steam plant to which a Diesel oil engine was being added, it was necessary to carry pipes across and underneath a busy 16-ft. driveway along which it was not possible to halt traffic while excavating even for one-half of the roadway at a time. Accordingly, it was decided to drive the pipe underneath. A pit on one side 7 ft. long was available from which to drive the pipe.

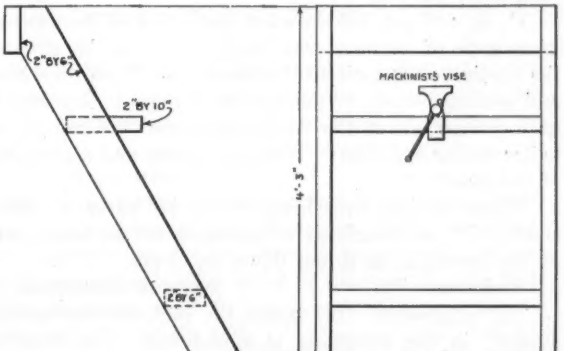
Several pieces of 10-in. steel pipe, secured from a junk yard were cut into sections 4 ft. long and threaded into ordinary screwed couplings. At the far end of the pit, which was about 4 ft. deep, a hole 2 ft. deeper was dug and some heavy timbers backed against the far side to form a backing for a 3 ft. long 5 t. jack. A horizontal hole was then scooped out in the opposite end of the pit and a 4-ft. length of the pipe pushed into the hole and alined and levelled until it was pointed in the desired direction. The pipe was then securely blocked in this position, the timbers at the other end of the pit accurately squared with the pipe and the jack placed in a horizontal position between the timbers and pipe. The latter was then forced into the earth as far as the jack could force it. The jack was then slid sidewise out of the way and some dirt loosened inside of the pipe and drawn out with a small hoe. A long crowbar was then used to loosen the dirt as far ahead of the pipe as possible and the dirt removed. These operations were repeated until the 4-ft. length had been driven in almost its entire length when another 4-ft. section was coupled on and the forcing and digging operations repeated.

Soon it was impossible to dig any farther as the available tools would not reach the soil at the far end of the pipe. This situation had been anticipated by the preparation of a large post hole digging auger which would just go inside of the pipe. A long handle, consisting of 4-ft. pipe lengths permitted the auger to be operated in the earth at the extreme end of the pipe. By unscrewing the handle sections the auger load of earth could be pulled out of the pipe. Screwing and unscrewing the handle sections had to be done many times but the object was accomplished without interfering with the traffic on the road.

Indianapolis, Ind. JAMES F. HOBART.

Portable Support Increases Availability of Vise

IN AN EASTERN power plant, the portable vise equipment shown in detail in the accompanying sketch is used with pronounced success. It consists of a small ma-



PORTABLE VISE FOR REPAIRS AROUND PLANT EQUIPMENT

chinist's vise and a bench which is of two-legged ladder type, supporting the vise. There are three cross pieces, one at the top and two below. The vise is secured to the second cross bar of support, while the bar is rested against any stationary object. The bottom bar is for a foot rest, which tends to steady the support while in use.

This small piece of equipment can readily be made from spare pieces of lumber and fills the need for a portable tool that may be quickly moved adjacent to any machine or other equipment. The support may also be of use in enabling the mechanic to reach inaccessible equipment by using the support as a ladder.

Washington, D. C. G. A. LUERS.

QUESTIONS AND ANSWERS

Water in Breeching May Cause Smoke

REFERRING to inquiry by F. M. on page 1006 of the September 15 issue, it is hard to say, without more complete data, to what extent water in the breeching will cause smoke. Smoke is caused by several conditions, some of which have no relation to water in the breeching.

An interesting case of occasional heavy smoke formation occurred under my observation. This was found to be due to a change in the grade of fuel. The better the fuel, the heavier the smoke. In this case there was no lack of draft or of temperature.

The fuel in this case was saw-mill and planing-mill waste. So long as the fuel consisted of slabs, damp saw-dust, etc., there was little or no smoke but when the planing-mill was running and a large percentage of the fuel was dried shavings, there was not only a very heavy smoke issuing from the stack, but also fire in the shape of burning chips. This fuel was fed through hoppers into a dutch oven and was carried along the roof of the dutch oven by a strong draft into the boiler passes and stack before it had a chance to be completely burned.

F. M. did not tell us what kind of fuel he used or what type of furnace was employed. Can he give us the vertical and horizontal dimensions of the breeching and sectional areas, if the section changes? Can he tell us anything about the draft pressures? What is the boiler rating and load? What is the size and dimensions of the stack?

Water in the breeching would be likely to cause smoke if it so restricted or changed the sectional area of the breeching as to cut down the draft.

Richmond, Va. ARTHUR SCRIVENOR.

The expression "the better the fuel, the heavier the smoke" in the foregoing is misleading. One kind of coal may indeed cost more, have less ash, clinker less and have a higher calorific value, but smoke more than another kind of coal. The qualifications given have little if any influence on smoke formation. If, for example, the coal contains a higher percentage of volatile matter, it is likely to smoke relatively more. A coal having the qualifications given may contain a high percentage of volatile, in which case not merely draft is needed, but proper introduction of supplementary air and proper design of furnace.

There are four fundamental conditions necessary for perfect, and therefore, smokeless combustion. They are:

1. Adequate supply of air.
2. Proper mixture of the air and combustible matter.
3. Sufficiently high temperature to permit chemical union between combustible and supporter.
4. Sufficient length of time to complete this chemical union.

In the case mentioned above, where dried shavings were used, the reason smoke was formed was that the burning fuel reached the cold parts of the boiler before they were consumed. Combustible gases were, therefore, lost by passing up the stack and carbon was distilled out forming the smoke. In this case the fourth requirement for smokeless combustion was disregarded. The flames should not have reached the cold parts of the boiler.

Water in the breeching may not only reduce the draft and hence limit the first requirement named, but, if evaporation of this water is rapid enough, also reduce the draft because of the attendant lowering of temperature of the flue gases at the base of the stack.

More facts are wanted, F. M. Let us have them.

Editor.

Steam and Evaporation Problems

CAN YOU GIVE me a few pointers on the following?

1. What is the percentage of moisture in the steam when the steam pressure is 145.3 lb. gage and the superheat in the throttling calorimeter is 21 deg.?

2. If a coal analysis is: 12 per cent moisture and 11 per cent ash and the actual evaporation is 6 lb. water per pound of coal as fired, what is the evaporation per pound of dry coal and per pound of "combustible"?

3. With a coal analysis as above and an evaporation of 6 lb. water per pound of coal as fired, what would be the equivalent evaporation from and at 212 deg. per lb. of combustible, the average steam pressure being 128 lb. abs. and the feed-water temperature 156 deg. F.?

V. K. S.

A. Assuming that the absolute pressure corresponding to the gage pressure of 145.3 is 160 lb. and that the pressure at the calorimeter outlet as registered by a manometer is 2 in. of mercury, the answer may be found either from steam tables or the Mollier diagram. The latter is by far the simpler method.

Two inches of mercury corresponds approximately to 1 lb. pressure. This added to 15 lb. atmospheric pressure would give an absolute pressure of 16 lb. in the throttling calorimeter. If the thermometer indicates a superheat of 21 deg., these two values can be used to locate a point on the Mollier chart which will indicate a total heat of 1162 B.t.u. per lb. of steam. The principle of the throttling calorimeter is based upon the fact that the heat content of the entering steam is equal to the heat content of the emerging steam so that if we follow the constant heat line horizontally to its intersection with the original pressure of 160 lb. abs., we find the quality of the entering steam to be about 96.5 per cent. The moisture content is, therefore, 3.5 per cent.

If steam tables are used, the same method is pursued. The heat content is found by interpolation to be about 1162 B.t.u. as before. The quality can be then calcu-

lated by the equation H = h + x L where H = total heat of the entering or emerging steam, h = heat of the liquid at the initial steam condition, L = latent heat of steam at the initial condition and x = quality of the steam at the initial condition. As the total heat content has been determined as 1162 and h and L are found from the tables to be about 128 and 1002 respectively, x can be calculated by transposing the equation to read x = (H — h) ÷ L = (1162 — 128) ÷ 1002 = 96.5 as before.

2. To find the quantity of dry coal; deduct the percentage of moisture, i. e. 1 — 0.12 = 0.88 = the percentage of dry coal in 1 lb. as fired. The evaporation per pound of dry coal will then be (100 ÷ 88) × 6 = 6.8 lb. of water.

"Combustible" consists only of products that are actually burned. We must therefore deduct not only the per cent of moisture but also the per cent of ash. There are other losses such as per cent of coal falling through grate unburned of which you give no data. Presuming no coal thus falls through the grate, the percentage combustible in one pound of coal as fired from the conditions you give will be 1 — (0.12 + 0.11) = 0.77 and the evaporation per pound of combustible will then be (100 ÷ 77) × 6 = 7.8 lb. of water.

3. In order to obtain the equivalent evaporation we must first find the "factor of evaporation" F

F = (H — h) ÷ 970.4

where H = total heat of steam at given pressure
h = heat of liquid at given temperature
970.4 = latent heat of 1 lb. steam at atmospheric press. according to Steam Tables by Marks and Davis
H at 128 lb. = 1190.7 according to Marks and Davis
h at 156 deg. F. = 123.86 according to Marks and Davis
F = (1190.7 — 123.9) ÷ 970.4 = 1.1

The equivalent evaporation per pound combustible will then be 7.8 × 1.1 = 8.58.

Heating System Water Supply

HELP on the following questions will be appreciated:

1. Is rain water better for use in a residence hot water heating system than the average city supply?

2. Should such a system be empty during the non-heating season?

3. What is the difference between the resistance offered by an angle globe valve and a gate valve?

G. A. P.

A. Yes.

2. It is best to drain the system but if it is kept full of water results will be quite satisfactory.

3. Valves, as well as fittings, made by different manufacturers vary, for similar sizes, in the resistance they offer to the flow of steam or water.

One authority gives the several resistances, based upon the resistance of a return bend equalling 1, to be as follows:

Globe valve = 2
Angle valve = 0.9
Gate valve = 0.25

From this the following relations are obtained:

Resistance through globe valve = 8 times resistance through gate valve. That through globe = 2.2 that of angle valve. That through angle = 3.6 times gate.

Another expresses the relation by showing the length of pipe that must be added to the measured length as equivalent to the addition of valves of certain types and fittings as shown in accompanying table.

TABLE SHOWING LENGTH OF STRAIGHT PIPE, IN FEET, EQUIVALENT IN RESISTANCE TO THAT OF VARIOUS VALVES AND FITTINGS

Size of Pipe in in.	Length in feet to be added in run				
	Std. Elbow	Side Outlet Tee	Gate Valve	Globe Valve	Angle Valve
2	5	16	2	18	9
2-1/2	7	20	3	25	12
3	10	26	3	33	16
3-1/2	12	31	4	39	19
4	14	35	5	45	22
5	18	44	7	57	28
6	22	50	9	70	32
7	26	55	10	82	37
8	31	63	12	94	42
9	35	69	13	105	47
10	39	76	15	118	52
12	46	90	18	140	63
14	52	105	20	160	72

For example suppose the measured length of 4 in. pipe containing one angle valve, one gate valve and four elbows is 132 ft., the equivalent length from which we may obtain the total resistance to flow would be

132 + 22 + 5 + (4 × 14) = 215 ft.

Calcium Carbonate Causes Trouble in Coal Analysis

WHY DOES the presence of calcium carbonate in the ash cause some trouble in the analysis of coal?

V. K. S.

A. In the process of ash analysis, the sulphur does not burn off in the presence of calcium carbonate, but goes first to calcium sulphide and then to calcium sulphate. But this behavior is erratic and depends largely upon the temperature employed.

Indeed as between a high temperature in ash determination approaching the fusion point and a really correct value for the ash, an error as great as 4 per cent may be introduced. The effect of the calcium carbonate is felt, therefore, only in the determination of the ash in the coal during the test.

Presence of calcium carbonate tends to lower the fusion point of ash.

Locating Barometers for Pressure Measurement

IN CHECKING the vacuum on surface condensers where should the mercurial barometer be placed for readings, in the turbine room, basement or outside of the building?

J. E. C.

A. Barometric readings are made to determine atmospheric pressure. The difference of atmospheric pressure in and out of a building is inappreciable for power plant purposes unless the inside location is one far removed from outside air as in a subbasement. In the latter case, it would be better to locate the barometer outside of the building or near an outside door or window.

EDITORIAL COMMENT

Models Aid Engineering Design

When the Engineering Foundation proposed to spend $100,000 to build a real life size dam out in California for the purpose of testing it to destruction, there was considerable feeling among laymen and some engineers that all this expense was unnecessary, that mathematics could be used to find out just what would happen and that what might be found out would be of value only in building dams that are practically duplicates of the one tested. Now that the dam has been built and tested in every conceivable way, nobody who is familiar with the problems involved and the data obtained, looks upon the experiment as a useless expenditure of money, since with the information thus obtained, many thousands of dollars may be saved in the construction of a single dam with the positive assurance that the structure will hold.

This gigantic experiment has now set standards to which dams of other designs will be compared, but as no two dams are alike in every detail, comparisons are extremely difficult to make and assumptions are dangerous. One of the things learned, however, is that miniature models can be built that will duplicate the conditions surrounding a proposed dam and this practice, which was seriously questioned in the past, is now being favored by leading authorities as the most satisfactory method of proving the practicability of a proposed design, as is pointed out in the article on page 1171 of this issue.

Building of models prior to the construction of the practical structure or device is probably as old as the engineering profession, but, as time has gone on, we have learned to depend more and more upon past experiences and mathematical calculations to give us the necessary design data. Calculations can, in most cases, be made at less expense than models, but the latter will frequently discover fallacies in reasoning or assumptions that make the added expense well worth while in cases where large sums of money are involved or where precedent has not been thoroughly established.

Due to variations in local conditions, hydraulic plants offer many problems, the like of which have never been solved and there is a decided trend toward a revival of the model making practice in this field of design, taking in not only dams but penstocks, draft tubes, tail races, spillways, and there is even a miniature Niagara Falls which was described in the September 1 issue, with which a study has been made of compensatory works to restore the natural beauty of the falls, which has been lost to some extent due to erosion and diversion of water for power purposes.

Another evidence of the value of experimenting with models is described on page 1156 of this issue, the equipment subject to investigation being centrifugal pumps built under rigid guarantees.

Thus we have laboratory methods brought into practical engineering design and construction and, as these methods have proved valuable in establishing scientific laws, so do the models prove the practicability or errors of a design.

Relay Settings on Distribution Networks

Upon no single piece of equipment used in the generation and distribution of electric power is placed greater reliance than upon the protective relay. Delicate in construction, silent in operation and usually mounted in out-of-the-way places, these seemingly unimportant, glass-enclosed devices give little visual indication of the important part they play in guarding the power system from damage and destruction. Yet to the platinum-tipped contacts of these instruments is entrusted the safety of millions of dollars worth of electrical equipment. Operating, perhaps, only once in its useful life, the effective performance of a protective relay in clearing a system of a single destructive short circuit is worth hundreds and sometimes thousands of times the amount invested in its installation and upkeep. The development and application of the protective relay can be classed as one of the major achievements of electrical engineering.

Relays, like all other things constructed by human hands, require human care. The function of a relay is dependent upon the establishment of certain conditions (usually accidental) in an electric system and unless these conditions can be predicted accurately, the entire value of the relay's properties will be lost.

For certain simple uses, the conditions under which a relay is required to operate are easily determined. Where a generator is to be protected against overcurrent, the relay setting is made in accordance with the known current-carrying capacity of the generator. In other cases, the problem of setting the relay correctly is more difficult.

On a large distribution network, fed from a number of separate generating stations or substations, and having many parallel paths, it is necessary to set the relays in such a way that a section of the system on which a fault occurs will be isolated within the shortest possible limits of both space and time. Relays on such systems must be able to distinguish, under abnormal conditions, between a fault in the apparatus or line protected and a fault on the rest of the system. Definite time overcurrent relays should operate in a definite order beginning with the ones farthest away from the generating station. A faulty section should be disconnected before any of the sections nearer the generating station, but the nearer the fault to the generating station the longer would it be allowed to remain on the system.

It is obvious that, in order to set relays for correct selective functioning on such a network, it is necessary to have an accurate knowledge of the current and power values in various parts of the system under short circuit conditions. To obtain this knowledge some large companies have built short-circuit calculating tables with which it is possible, by means of variable resistances to arrive quickly at the correct current values in all parts of the actual system for any abnormal condition. Where such short-circuit calculation tables are not available, however, numerical calculation must be used.

It is with reference to the calculation of such circuit data that we direct attention to an article by Elliott McCormack in this issue, which describes a method of calculation for determining the proper relay setting for any system. This method is used by one of the large systems in the east and is of interest because accurate results are obtained by means that anybody with a limited knowledge of simple mathematics can use.

The High Cost of Fuel Saving

"Few people have paid sufficient attention to the high cost of fuel saving," says Professor Trinks of Carnegie, in a paper prepared for the First National Fuels Meeting recently. "That the saving of fuel and its conservation for future generations are desirable is almost an axiom," he continues, "about the truth of which there can be no discussion. But under the present economic order it is unfortunately cheaper to waste fuel than to save it, at least in many localities and under many circumstances."

Professor Trinks then shows how in many industries, certain types of power plant equipment are in use which consume more fuel than certain other types that might be employed. The question here, however, is one of immediate saving in dollars and cents rather than of saving fuel for the future. The less economical equipment, using a little more fuel, costs less to operate now. Cost of going to higher steam pressure, by which fuel might be saved, is often prohibitive. In industrial processes employing fuel, great wastes of fuel occur, due to the high cost of the equipment needed to save it. Fuel waste in house heating occurs because of the high cost of proper insulation, since most houses are built to sell or rent.

All of these facts lead up to the main argument of Professor Trinks' thesis, which is that, at present, fuel saving is a paying proposition only in those processes in which the cost of fuel is so great that it overshadows wages and salaries. This situation would at once be changed if fuel suddenly became scarce and expensive. Then it would pay to save it and the fuel engineer and the equipment he uses would become dominating factors.

Professor Trinks proposes, therefore, that artificial means be used to make fuel expensive. He proposes that the government levy a tax on fuel. This would create an income and surplus out of which the government could pay a large part of the cost of the fuel saving equipment, which would then cost little more than the fuel wasting equipment. Standards for fuel consumption of the equipment would have to be worked out to determine the subsidy to be paid in each case, "but," says Professor Trinks, "engineering societies would doubtless put this on a sound basis, reasonably free from politics or graft."

We note with considerable glee the word "reasonably" in the preceding sentence. Nevertheless, we present Professor Trinks' idea (which he has advanced before) for what it may be worth. Whether or not the reader agrees with his conclusions, he must agree that the cost of saving fuel is the principal factor with which the power plant engineer is concerned. For that reason, the idea of artificially making it profitable to save fuel merits attention, especially when advocated by a man of the standing of Professor Trinks.

"Metropolis"

We are going to turn critic for the moment. We are going to turn movie critic. And, in particular, we are going to criticize the motion picture "Metropolis," artistically and technically one of the greatest films that has ever been produced. Professional critics may take umbrage at these statements (for they are expert takers of umbrage) but we have put our hand to the plow, etc., we would rather be right than be president, honesty is the best —oh, well, anyway, Metropolis is a great picture.

As you sit in the darkened theater and watch the unfolding of the workers' dramatic struggle against enslavement by the machine and their final victory (spoiled by a scene of sentimental slop at the very end) you are fascinated. But to enjoy the picture you must accept the major premise on which the argument is based. And it is the major premise which, to our way of thinking, is entirely wrong. The fact that it is wrong does not matter, of course, from the artistic standpoint.

The major premise of "Metropolis" is that, as our present industrial development goes on, the workers will be physically enslaved to the machines they operate and that the increased speed of production of those machines will demand only physical labor of the most exhausting kind, turning men virtually into automatons and clods, without intelligence or hope. If you accept this premise temporarily, you can view the motion picture as a plausible story. This does not alter the fact, however, that the premise is wrong.

It is wrong because every tendency of the industrial world of today is to replace drudgery of the worker by mechanical appliances which function automatically and far more accurately than a man, also much faster than any man can work. This is the tendency although it must be admitted that it is still only a tendency and that, in many industrial processes, human beings are still doing physical, unintelligent work that could be better done by a machine, with the man supervising its operation. No better illustration exists of the tendency toward mechanical, automatic functioning and elimination of physical hardships than the power plant field.

Because of the great numbers of people who have seen "Metropolis" and will see it in the future, we feel that it is worth while to point out that its plot is based on an assumed tendency of industry exactly the opposite of the tendency that already exists. The story is so well told and so plausible that the literal-minded, of whom there are so many in the motion picture audiences, will see in it not an attempt to create certain artistic and emotional effects but rather a forecast of a future development. We feel that it was not so intended. Such a forecast would ignore the entire present trend of modern industrial development.

POWER PLANT ENGINEERING DEVELOPMENTS AND NEWS

New S-A Simplex Carrier

STEPHENS-ADAMSON Manufacturing Co., Aurora, Ill., has recently placed on the market a new type of belt conveyor carrier which embodies several improvements both in construction and design. The new carrier is known as the Stephens-Adamson Simplex carrier, the complete line including carriers for belts ranging in width from 12 to 60 in. The carrier proper consists of three rollers in line, the troughing rollers being mounted at a 20-deg. angle to increase the capacity of the belt.

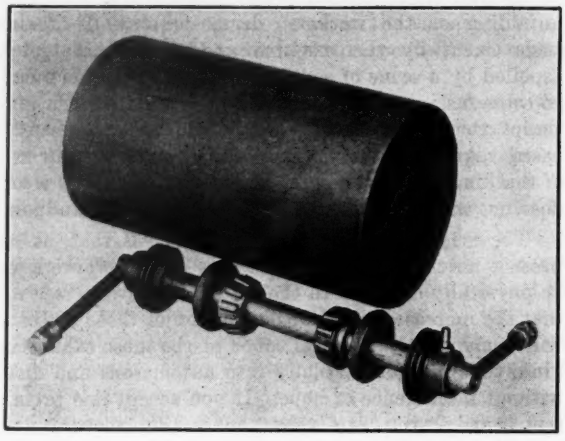


FIG. 1. EACH ROLLER IS EQUIPPED WITH TWO ROLLER BEARINGS

Carriers are mounted on a heavy steel angle section base, which is self cleaning. The whole assembly is tilted slightly in the direction of belt travel, to facilitate the proper training of the belt.

Rollers are self-contained units of steel tubing, with drawn steel end plates. The ends of the rollers are rounded to protect the belt from fraying, or wear. Each roller is equipped with two Timken bearings, the cones of which are pressed onto the roller shaft and located by a washer while the cups are pressed into a steel tube which forms the roller axle and are located by shoulders in the tube. Bearings are protected from dust and other foreign substances by a combined labyrinth washer and multiple groove grease seal. Permanent adjustment of the bearings is provided for by lock screws.

The rollers proper are mounted on strong malleable iron stands which are so constructed that it is a simple matter to swing them out of the way and thus remove the roller bodily.

Each roller shaft is equipped with two high pressure grease fittings, one at each end, which project far enough to make them readily accessible. The shaft has drilled passages, which connect the fittings with the interior of the tube in which the bearings are mounted, the latter serving as a reservoir for the lubricant. A space has been left between the bearings and the outer

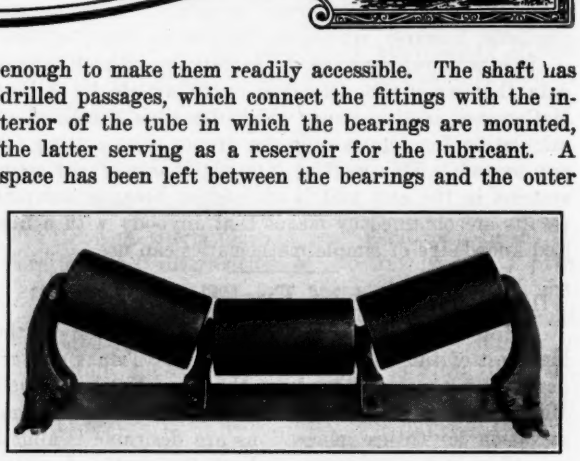


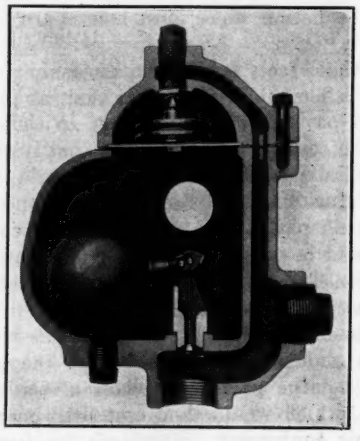
FIG. 2. THREE ROLLERS ARE MOUNTED ON ANGLE BASE

closure, into which grease is forced by the pumping action of the bearings themselves.

All the parts of the carriers, such as bearings, shafts, rollers, brackets, and complete roller assemblies are mutually interchangeable for belts of the same size..

Webster Drip Trap Designed for Large Capacity

FOR USE IN HEATING SYSTEMS at maximum working pressure of 10 lb. per sq. in., to drain condensate and air from mains or from large heating surfaces such as unit heaters or blast coils, the Webster



FLOAT-CONTROLLED VALVE DISCHARGES CONDENSATE WHILE THERMOSTATIC ELEMENT HANDLES AIR

drip trap shown herewith has recently been developed. It is designed for mounting right in the pipe line with-

out other support. It weighs 18 lb. and is rated at capacities from 500 lb. of condensate an hour at ¼ lb. per sq. in. pressure difference to 1800 lb. an hour at 10 lb. pressure difference.

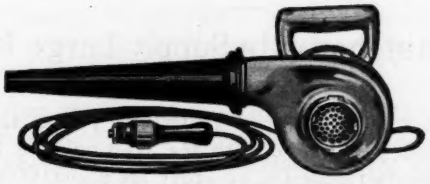
This trap consists of a thermostatic element for discharging air and a float-operated valve for discharge of water. Two inlet and two outlet openings are provided for convenience in installation, together with an opening in the cover so that air can be discharged separately to dry return when desired. The thermostatic element is fastened to a disc held in place as shown, between the body and cover, by the cap and the copper-asbestos gasket. The float and valve assembly is held in place by two monel metal studs and this assembly is removable as a unit. All interior parts are of brass, copper, monel metal or bronze.

Inlet and outlet openings are for 1¼-in. pipe and are provided in duplicate for ease in mounting with either left-hand or right-hand inlet and horizontal or vertical discharge. One inlet and outlet are plugged when shipped and the others are bushed with 1¼ by 1-in. bushings, in case it is desired to install the trap in a 1-in. line. If not, the bushings are quickly removed.

This trap is the latest produce of Warren Webster & Co., Camden, N. J., which has issued Bulletin 712 describing it.

Tornado Portable Electric Blower

FOR BLOWING destructive dust out of motors, machinery, shafting and the like with powerful blasts of clean dry air, a super-powered portable type of small electric blower is announced by Breuer Electric Mfg. Co., 844-856 Blackhawk St., Chicago. It is called



TORNADO PORTABLE BLOWER

Breuer's Ball-Bearing Tornado Portable Electric Blower No. 6 and is equipped with a ⅓-hp. G-E motor mounted on Norma Precision Ball Bearings, which require no oiling. It weighs 7 lb. and a 20-ft. reenforced cord and separable steel covered plug with wood handle connects it to any electric socket. Suction attachments and a dust-bag may be obtained for converting the Tornado into an electric suction cleaner.

Portable Watthour Meter Compensated for Temperature

SEVERAL ADVANTAGES over old types are incorporated in a new portable standard watthour meter recently placed on the market by the Westinghouse Electric & Mfg. Co., the outstanding advantage being the compensation for temperature errors at both unity and low power factor. This compensation is inherently permanent for both the electromagnets and the permanent magnets and does not depend on the movement of mechanical parts with the variation in temperature.

Superior accuracy is obtained along with a decrease in size and weight. These latter features are important considerations in a portable meter, especially where

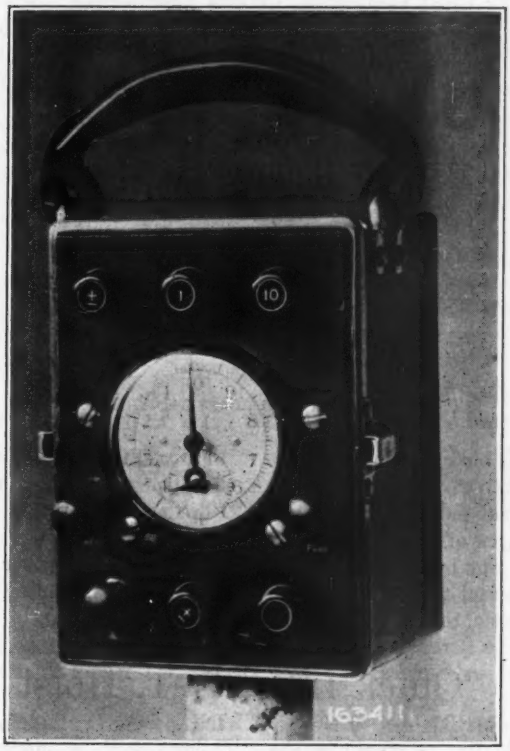


FIG. 1. OUTSIDE VIEW OF NEW OB TYPE WESTINGHOUSE PORTABLE WATTHOUR METER

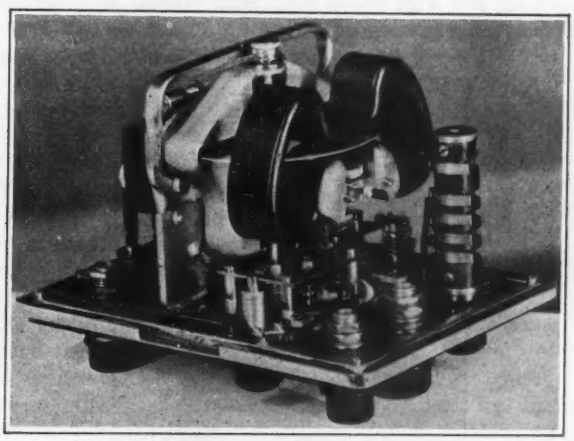


FIG. 2. VIEW OF METER WITH COVER REMOVED TO SHOW CONSTRUCTION

a great many meters are to be tested at widely separated points. The micrometer adjustments have been simplified and the electromagnets are of the one piece OB type. A zero reset is provided by which both pointers can be set on zero. Potential settings are changed by means of a small switch, and three current binding posts are used, so that the meter may be connected for either 1 or 10 amp. capacity.

Coppus Ventilator for Hot Spots

FOR COOLING hot spots, not reachable or reached by usual ventilation, Coppus Engineering Corporation has incorporated its Vano blower in a portable unit with horn-shaped diffuser which directs the blast to any desired location where a heat pocket is encountered.

COPPUS PORTABLE BLAST VENTILATOR

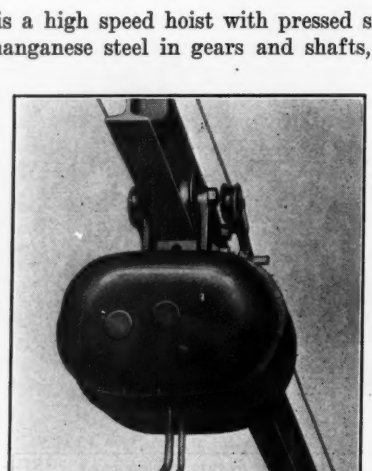
It is mounted on a tripod 4 ft. high and is provided with starting switch. One size is equipped with ½-hp. universal motor, the other with 1-hp. motor suited to the source of power supply.

For boiler rooms, foundries, steel mills or other industrial plants where conditions make local cooling desirable, this equipment can conveniently be used.

"Quick Lift" ¼-T. Hoist

AMERICAN ENGINEERING CO., Philadelphia, Pa., announces the "Quick-Lift," a moderate priced, all-steel, quarter-ton electric hoist, shown herewith.

This is a high speed hoist with pressed steel frame, chrome-manganese steel in gears and shafts, ball bear-



TROLLEY TYPE ¼-T. HOIST REQUIRES 16-IN. HEADROOM

ings, non-spinning hoisting rope, oil bath lubrication, push button control and upper and lower limit switches. All working parts are fully enclosed.

The hoist weighs 200 lb. and is made in two types—plain trolley and hook suspension. The plain trolley type requires 16-in. headroom and the hook suspension type 18 in.

75,000-Kw. Turbine for Buffalo General Electric Company

FOR INSTALLATION in the Charles R. Huntley station of the Buffalo General Electric Co., a single-cylinder steam turbine of large capacity is being manufactured. The new unit will be rated at 75,000 kw., and will increase by nearly 50 per cent the present station capacity of 155,000 kw.

Constantly increasing demand for power in the vicinity of Niagara Falls, and the fact that the present international agreement will not permit more water to be diverted from the falls for hydroelectric generating purposes, makes it necessary for a continually larger amount of steam-generated power to be distributed in addition to the basic power from Niagara.

Although the Buffalo General Electric Company a year ago installed a 60,000-kw. unit in this same station to take care of increased load conditions, peak demands have occurred since, in the season of lighter loads, which indicate clearly that more capacity is urgently needed.

Though the new unit is the largest of its kind ever built, it will by no means overshadow the five present units in the Huntley station, since these are of 20,000 35,000 and 60,000 kw. capacity, the smallest being large enough to take care of the electrical needs of a good sized city. The new machine will be used to deliver base power, while the smaller ones will act as standbys for peak conditions.

The new 75,000-kw. unit will be of General Electric manufacture. It will be rated at 83,333 kv.a., 90 per cent power factor, 1500 r.p.m., 25 cycles. The turbine will be operated under standard station steam conditions of 250 lb. pressure, 250 deg. superheat, and one inch absolute back pressure.

Westinghouse to Supply Large Units for Hell Gate

THE UNITED ELECTRIC LIGHT AND POWER CO., New York, has just placed with the Westinghouse Electric and Manufacturing Co. an order for a 165,000-kw. turbine generator unit and two surface condenser equipments with the necessary auxiliaries. The new unit will be built at the South Philadelphia Works and installed in the Hell Gate Power Station at New York. The turbine will be of the cross compound type and operate at a speed of 1800 r.p.m. Steam will be supplied to the throttle at 265 lb. gage pressure, 290 deg. F. superheat and will pass into the condenser at a pressure of one inch of mercury absolute.

The two main generators, the largest on order today for operation at 1800 r.p.m., will each have a rating of 80,000 kw., 85 per cent power factor, producing 3-phase, 60-cycle current at 13,800 v. An auxiliary generator rated at 5000 kw., 80 per cent power factor, producing 3-phase, 60-cycle current at 2400 v., will also be furnished. Direct connected exciters will be supplied for both the main and auxiliary generators.

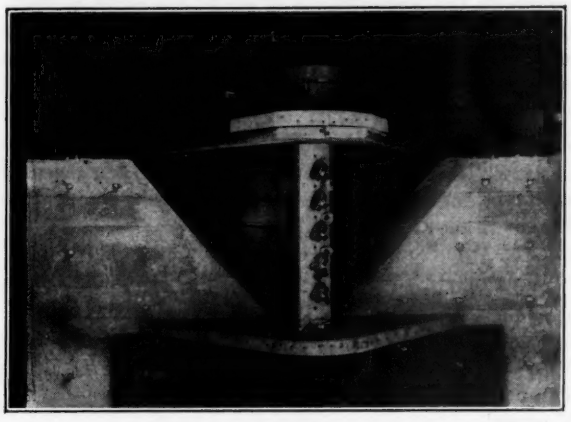
One condenser will serve the above generator unit, and the other condenser will serve the 160,000-kw. cross compound unit, purchased over a year ago for delivery next year.

Each of the condensers is of the two-pass design, having 137,500 sq. ft. of tube surface, and is arranged to circulate 155,000 g.p.m. by two motor-driven circulating pumps. The air removal equipment for these condensers will be of the three-stage air ejector type.

Celluloid Model Checks Stevenson Dam Tests

UNDER SUPERVISION of the Committee on Arch Dam investigation of the Engineering Foundation, 29 W. 39th St., New York, a celluloid model of the Stevenson Creek arch dam has been contrived by Prof. Geo. E. Beggs of Princeton University, assisted by D. B. Sloan, a graduate student of the Princeton Engineering school.

The Engineering Foundation could not afford to build and test more than one full size dam, since the expense would approximate $100,000 for each such undertaking. Yet the information needed could not be



CELLULOID MODEL OF STEVENSON CREEK EXPERIMENTAL ARCH DAM, LOOKING AT DOWNSTREAM FACE, WHILE MODEL IS UNDER TEST

obtained from one specimen. It was this situation that led to the celluloid model and to the planning of other models. These have been used successfully for various types of engineering design.

After measuring the deflections and strains caused by the pressure against the model dam, it was discovered that there was a remarkably close agreement between the tests and computations of Prof. Beggs and the very accurate measurements made on the experimental dam itself.

The model is 18 in. high or 1/40 the height of the Stevenson Creek Dam and a little over one-half inch thick for the greater part of its height. The reservoir is ¼ in. long and contains mercury instead of water because mercury caused proportionately greater deflections and strains. The reservoir is short because the pressure of the fluid against the dam varies with its depth and not with the distance it extends back of the dam. Interesting and ingenious methods were used to measure the deflections of the model under the pressure of the mercury in the reservoir.

It is concluded by Prof. Beggs that the use of the model is of advantage as it gives accurate results without intricate mathematical computations and allows greater freedom in artistic and mechanical design of the structure.

All Contracts Let for St. Louis Municipal Plant

CONTRACTS for the last of the equipment for the Municipal Heating Plant in the Municipal Building, St. Louis, have been signed and construction is well under way. This plant is designed for eight 500-hp. boilers and, although at the present time only three will be installed, foundations, piping, coal bunkers, coal and ash handling equipment and structural work will be completed so that the only necessary work when the additional units are installed will be putting them on the foundations and connecting them with the steam header.

For the present the plant will consist of three 500-hp. Heine boilers fired by Illinois stokers and with Link-Belt coal elevators and conveyors and bunkers. Two Wiederholdt stacks 128 ft. high and 13 ft. in diameter will be built.

It is expected that this plant will be in operation by October, 1928, and at that time will supply the municipal courts, city hall, jail, morgue and the county court house with steam. Eventually the auditorium and the Memorial Building will be added and additional boiler units installed as the load increases.

News Notes

AS THE TIME APPROACHES for the Sixth Annual Exposition of Power and Mechanical Engineering, to be held in the Grand Central Palace in New York on December 5 to December 10, attention of manufacturers and engineers everywhere is beginning to focus on this event. According to a recent statement by the management of the exposition, over 500 companies will exhibit their products at this Power Show.

These exhibits will include, of course, every type of machinery for power generation. Among the features of interest will be many exhibits of heating and ventilating equipment in which engineers and industrialists are interested more and more each year. Material handling equipment is of interest not only to the power plant engineer but to the production engineer, as are also power transmission equipment, measuring and recording instruments and the like, all of which will be displayed at the Sixth Power Show. Besides all this, an interesting program of lectures and motion pictures is to be held during the Show, while during the same period the annual meeting of the American Society of Mechanical Engineers takes place, together with meetings of the American Society of Refrigerating Engineers, American Society of Heating & Ventilating Engineers, and several others.

Complete information regarding the exposition can be obtained from the management at Grand Central Palace, New York City.

CONSIDERABLE INTEREST has been aroused by the announcement that purchases are now being made for a hydroelectric project on the Dnieper River in Russia as noted recently in these columns. Hugh L. Cooper & Co., New York City, was engaged by the government of the U. S. S. R. on February 21, 1927, to act as chief consulting engineer for this power and navigation development which is located at Kichkas, Ukraine, at a point

on the Dnieper River about 250 mi. north of the Black Sea.

The project includes the building of a concrete, masonry faced dam, raising the natural levels of the river about 120 ft. for its width of approximately 2400 ft. and the building of a three-stage navigation lock, power house and other appurtenances.

The canal and lock system will open a hitherto unnavigable reach of the river, extending navigation some 800 miles upstream; a very important consideration in the commercial development of the Dnieper Valley.

The initial power installation calls for seven units of 50,000 hp. capacity each, this installation to be later increased to 13 units of 50,000 hp. capacity each.

The thickly populated territory to be served by the proposed plant is reported to be rich in minerals and the government proposes the construction of new metallurgical plants, ferro-manganese works, aluminum works and electrolytic steel plants.

The development is being financed by the government whose estimated cost of the project is $75,000,000 based on a five-year construction program. A staff of American engineers is now resident at the site to supply continuous construction advice to the government engineers in charge of the administration of labor.

A considerable amount of American construction equipment has been purchased for the project and it is expected that these orders will be substantially increased as the work requires.

ROLLER-SMITH Co., 233 Broadway, New York City, announces the appointment of D. H. Braymer Equipment Co., W. O. W. Bldg., Omaha, Nebr., as its representative in Nebraska and western Iowa.

CONNERY & Co., INC. of Philadelphia, Pa., has recently completed a two-story addition to its plant at the corner of 2nd and Luzerne Sts., which will increase floor space 50,000 sq. ft. or 50 per cent, giving greater facilities for prompt filling of orders.

BAILEY METER Co., Cleveland, Ohio, has moved into its new quarters at 1040 Ivanhoe Road, Cleveland, where approximately three times as much floor space is available as existed in the old plant on E. 46th St. The main office of the company, as well as the manufacturing equipment, is now at 1040 Ivanhoe Road.

ELLIOTT Co., Jeannette, Pa., has recently added to its sales staff E. H. Haslam and H. K. Gowdy. Mr. Haslam has been engaged in consulting work in Chicago and previously had broad experience in the iron and steel industry. Mr. Gowdy, after extensive power plant experience in central stations, railway and industrial plants, has also done consulting work and has been connected with the Allis-Chalmers Mfg. Co. and the Standard Oil Co. of New York.

KANSAS CITY Light & Power Co. has closed contract with the Combustion Engineering Corp. of New York for two complete steam generating units for its Northeast station, each unit to deliver 250,000 lb. of steam an hour continuously. Boilers are to be designed for 1400 lb. pressure. Units include Lopulco unit system for burning pulverized fuel, water-cooled furnaces, economizers and air preheaters.

ACCORDING TO A RECENT STATEMENT by Arthur W. Thompson, President, The United Gas Improvement Co., Philadelphia, Pa., the consolidation of interests of The United Gas Improvement Co. and the Philadelphia Electric Co., which has been approved by the Boards of Directors of both companies, has been discussed for years and several efforts have been made for the past 10 or 15 yr. to bring it about.

"It is made possible now because the stockholders of both companies have come to recognize that it is demanded by the higher standards of service of today," said Mr. Thompson. The Philadelphia Electric Co. will not lose its corporate identity.

WALTER SENNHAUSER, formerly mechanical engineer for Sulzer Bros., Ltd., Winterthur, Switzerland, has arrived in this country to assume the duties of chief engineer of the Dry Quenching Equipment Corp., a new subsidiary of the International Combustion Engineering Corporation, which has acquired American rights to the Sulzer system for dry quenching coke.

THE KENNEDY VALVE MFG. Co. of Elmira, N. Y., announces the appointment of R. J. Flanagan as manager of its Chicago Sales Office and Warehouse. His previous position as Elmira District Representative is being taken by J. T. Connelly who has been transferred to Elmira from the Cleveland Sales Office, and W. E. Blake is to replace Mr. Connelly in Cleveland.

H. R. HARRIS, 1123 Metropolitan Life Bldg., Minneapolis, Minn., has just been appointed as representative of The Falk Corp. of Milwaukee, Wis., to cover the state of Minnesota and also Douglas County, Wis.

THE WELLMAN-SEAVER-MORGAN Co., Cleveland, Ohio, announces the incorporation of an associated company in Canada known as the Canadian Wellman-Seaver-Morgan Co., Ltd., with head office at 307 Reford Bldg., Toronto, and branch office at 808 Drummond Bldg., Montreal.

NATIONAL REGULATOR Co., 2301 Knox Ave., Chicago, Ill., announces that Dudley F. Parker succeeds F. C. Gibbs as Eastern Manager with offices at 166 Lexington Ave., New York City. Mr. Gibbs has been forced to retire, due to an injury.

WALTER SPRINGE, for many years identified with the sale of power equipment in Kansas City and St. Louis territories, as representative of the Heine Boiler Co., has recently been appointed district manager for that district for the Combustion Engineering Corporation, in charge of sales of all types of steam generating and fuel burning equipment. R. J. Robinson has been appointed as branch manager at St. Louis, under Mr. Springe.

THOMAS B. DAVIS died Sept. 20, at his home, 605 Twenty-sixth St., Rock Island, Ill., as the result of heart disease. He had been seriously ill only the last 10 days. He was a pioneer in the electric utilities field in that community, establishing a 50-light arc dynamo in the Moline Waterworks plant Feb. 9, 1884, after this system, which he had founded, was taken over by the municipality. The Merchants' Electric Light Co. was organized to operate this plant and the following year he organized a similar enterprise in Rock Island. In 1887 the People's Light & Fuel Manufacturing Co. was organized and the Moline Gas & Coke Co. and the Merchants' Electric Light system were taken over by

it. The People's Light Co. of Davenport was formed the next year. From this nucleus, the Davis interests developed the tri-city utilities and in 1898 acquired the Sears power dam on Rock River, dormant at that time for two decades, and rebuilt it, the plant still furnishing power for the People's Light Co., which has now become a subsidiary of the United Light and Power Co. His interests have been varied and at the time of his death he was president of the Moline Water Power Co., vice-president of the Rock Island Plow Co.; president of the Denkman Lumber Co. and director in the Weyerhaeuser & Denkman Co. and the various subsidiary companies controlled by it in the lumber industry.

AMERICAN ENGINEERING Co., Philadelphia, Pa., announces the appointment of George L. Drake as agency sales supervisor for its Lo-Hed hoist division.

THE HARBISON-WALKER REFRACTORIES Co. of Pittsburgh, through an exchange of stock, has acquired the Walsh Fire Clay Products Co. of St. Louis, Mo.

PENNSYLVANIA PUMP AND COMPRESSOR Co., Easton, Pa., announces that E. P. Maixsell, formerly sales manager at Easton, has been appointed manager of the New York office, 136 Liberty St.

THE RELIANCE ELECTRIC & ENGINEERING Co., 1042 Ivanhoe Road, Cleveland, Ohio, announces that R. A. McDowell, formerly of Pittsburgh, has been made district manager at Cincinnati. C. D. Herbert, formerly at Syracuse, has been made district manager at New York City.

READING IRON Co., Reading, Pa., announces that J. H. Somerville, recently connected with its Philadelphia office, has been appointed to the Baltimore office to assist W. J. White, District Sales Representative. C. M. Barr has been appointed to succeed Mr. Somerville at Philadelphia.

THE PENNSYLVANIA-OHIO POWER & LIGHT Co., Youngstown, O., is arranging an expansion program covering a period of five years and involving an expenditure of about $50,000,000 for improvements, new power stations, transmission lines and other increased facilities.

THE CASEY-HEDGES Co., Chattanooga, Tenn., announces that Thomas Carlson, formerly chief engineer for the Erie City Iron Works, has joined its engineering staff.

THE WEST FLORIDA POWER Co., Tallahassee, Fla., has work in progress on a new hydroelectric plant on the Ocklecknee River, about 26 mi. from the city. It is expected that the station will be ready for service in about a year. Two vertical generating units will be installed with a capacity of 12,000 kw. as the initial installation. The company is operated under the direction of the General Engineering & Management Corporation, New York.

SALE OF MECHANICAL stokers during September, 1927, by twelve establishments, as reported by the Department of Commerce, show a total of 97 stokers sold installed under boilers of 26,093 hp. capacity. Of this amount 43 were installed under fire-tube boilers of 6,481 hp. capacity and 54 under water-tube boilers of 19,612 hp. capacity. The report for this month shows a sudden decrease in total number of stokers sold, the figures for August being 160 stokers under boilers of 60,977 hp. capacity. The greatest decrease appears to be in the number sold for water-tube boilers.

STOCKHOLDERS' MEETING of The Brown Hoisting Machinery Co. was held at the company's office in Cleveland on Monday, Sept. 26, and without any dissent approved the merger and consolidation with Industrial Works of Bay City, Mich. A similar meeting was held by the stockholders of Industrial Works, who also approved the merger. The name of the new company is Industrial Brownhoist Corporation. It is organized under the laws of Ohio with general office at Cleveland. Alexander C. Brown is president of the new company.

THE HILL CLUTCH MACHINE & FOUNDRY Co., Cleveland, Ohio, announces the opening of the new Metropolitan District Office, Room 528, 30 Church St., New York City, in charge of Charles C. Phelps.

THE TAMPA ELECTRIC Co., Tampa, Fla., has plans under way for a new steam generating plant in the Hooker's Point district. Plans will be drawn and construction supervised by Stone & Webster, Inc., Boston, Mass.

THE TIMKEN ROLLER BEARING Co., Canton, Ohio, together with B. U. Dewar of London, England, have purchased from Vickers, Limited, all of the capital stock from British Timken, Limited. This purchase gives Timken complete control throughout the world of the manufacture and sale of Timken bearings.

H. W. BROOKS has resigned as consulting engineer for Erie City Iron Works, Erie, Pa., to engage in private consulting practice with offices in New York and St. Louis. His residence address remains as before, 1300 McPherson Blvd., Freemont, Ohio.

Mr. Brooks has conducted research and development work in combustion and steam engineering and was formerly fuel engineer for the United States Bureau of Mines and Chief of the Machinery Section, Bureau of Ordnance, U. S. Navy. He is a member of A. S. M. E. and A. I. E. E.

ALBERT A. CARY, mechanical engineer, 95 Liberty St., New York City, died on August 31, 1927. Mr. Cary specialized in furnace and boiler design and furnaces for various fuels and in the design of complete steam power plant equipment and industrial mechanical equipment. He was a member of the American Society of Mechanical Engineers and a graduate of Worcester Polytechnic Institute.

MEN FINANCIALLY interested in the Northern Nebraska Power company, have incorporated the Niobrara River Power company with $100,000 capital to build a mile-wide dam 50 ft. high across the Niobrara, 15 mi. southeast of Spencer, Nebr., E. A. Forbes, W. D. Bradstreet and A. W. Person are listed as incorporators. The new dam site is 7 mi. southeast of the Northern Nebraska's present dam.

ROBERT JUNE, Advertising, Detroit, Mich., announces that in order to extend and improve facilities of the organization, he is moving his office from the building formerly occupied at 2208 Grand Blvd. to the General Motors Bldg., Detroit, Mich.

ANNOUNCEMENT IS MADE of the election of William H. Hodge as a vice-president of Byllesby Engineering and Management Corporation, 231 S. La Salle St., Chicago, Ill. He is also appointed as manager of a newly

created sales and advertising department of that company.

THE BROOKLYN EDISON CO., Brooklyn, N. Y., is arranging for additional equipment at its Hudson Avenue generating plant to be used with a new 147,500-hp. turbo-generator to be installed there. Contract has been placed with the Westinghouse Electric & Mfg. Co. for a single-pass surface condenser, with total surface area of 85,000 sq. ft. Another order has also been given to the Westinghouse Elec. & Mfg. Co. for four mechanical stokers to be installed with the new 2400-hp. boiler units at this plant.

THE NEW YORK STEAM CORP., 280 Madison Ave., New York, plans to carry out an extension program at its new Kips Bay Steam Station to increase the capacity.

THE TEXAS-LOUISIANA POWER CO., Fort Worth, Texas, plans the construction of a new steam generating station at Texas City, Texas.

THE KENTUCKY UTILITIES CO., Earlington, Ky., is planning an addition to its steam power plant reported to cost about $300,000.

THE UNITED ELECTRIC LIGHT CO., Springfield, Mass., has awarded to S. Rodney Hunt Mfg. Co. contracts for two water wheels for its water power station at Indian Orchard, Mass. Stone & Webster, Inc., are engineers for the power station.

Catalog Notes

THE HAYS CORPORATION, Michigan City, Indiana, has just issued a reprint of an address by J. T. Vollbrecht on trouble shooting in the heating plant.

CLEVELAND CRANE & ENGINEERING CO., Wickliffe, Ohio, in bulletin No. 1001 discusses the design of the Cleveland tramrail rail.

THE INTERNATIONAL NICKEL CO., 67 Wall St., New York, N. Y., has issued bulletin No. 203 describing the economic value of nickel in cast iron and Bulletin No. 204 describing the effect of nickel on machinability of cast iron.

WORTHINGTON PUMP AND MACHINERY CORP., 115 Broadway, New York, has issued Bulletin No. W613 describing its new line of high efficiency ball-bearing centrifugal pumps for general service.

THE IDEAL ELECTRIC & MFG. CO., Mansfield, Ohio, in circular No. 500 prepared by Theo. Schou, chief engineer, discusses "Flywheel Effect Recommendations for NH_3 and CO_2 Compressors based on Ideal Synchronous Motor Drive."

TYPE AA RELIANCE INDUCTION MOTORS with ball bearings, for two- and three-phase alternating current circuits, are described in bulletin No. 101 by Reliance Electric & Engineering Co., Ivanhoe Road, Cleveland, O.

THE PYROMETER INSTRUMENT CO., 74 Reade St., New York, has issued bulletin 20 describing the Pyro Radiation Pyrometer for temperatures exceeding 1000 deg. F.

BULLETIN No. 32-B., superseding Bulletin 32, issued by the Delta-Star Electric Co. of Chicago, describes their line of disconnecting switches, fuse mountings and choke coils for outdoor high tension service.

GEARED TURBINE GENERATOR Units, 75 to 500 Kw. for A.C. and D.C. Operation, is the subject of a new and attractive leaflet, No. 20,293, recently issued by the South Philadelphia Works of the Westinghouse Electric and Manufacturing Co. A number of photographs, showing the construction of these units, is included.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

required by the Act of Congress of August 24, 1912, of Power Plant Engineering, published semi-monthly at Chicago, Ill., for October 1, 1927.

State of Illinois, } ss.
County of Cook. }

Before me, a Notary in and for the State and county aforesaid, personally appeared Charles S. Clarke, who, having been duly sworn according to law, deposes and says that he is the Secretary of the Power Plant Engineering, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Technical Publishing Co., Chicago, Ill.
Editor, Arthur L. Rice, Chicago, Ill.
Managing Editor, R. E. Turner, Chicago, Ill.
Business Manager, E. R. Shaw, Chicago, Ill.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Technical Publishing Co., Chicago, Ill.
E. R. Shaw, Chicago, Ill.
Arthur L. Rice, Chicago, Ill.
K. L. Rice, Chicago, Ill.
Charles S. Clarke, Chicago, Ill.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

There are none.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is..... (This information is required from daily publications only.)

Chas. Sanford Clarke, Secretary.

Sworn to and subscribed before me this 26th day of September, 1927. Ada L. Durland.

(My commission expires February, 1931.)

NOTE.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.

Sparks from the Advertising Pages

Where Buyers and Sellers Meet

That the Work of the Builders Shall Not Fail

Ancient man depended for life itself on the quality of the weapons and utensils he crudely shaped with ungainly tools. Mankind now depends on efficient and widely available light, heat and power for the means to enjoy the comparative abundance of today.

Armed with an electric drill, a modern typesetting machine, a turning lathe, a mighty steel crane, or any of the thousand and one other pieces of equipment with which to do his work, modern man fights the battle of life at an advantage never before equalled.

With power plants back of him and his working tools, he has speeded up the work and reduced physical labor until he has risen to unprecedented heights of security and comfort and to an enlarged measure of time and means for a broad existence.

The demand for better engineering ability and greater engineering leadership, is more insistent than ever before. Power plant men everywhere are preparing themselves to meet this demand that exists now and is bound to grow with the years to come.

The New York Power Show, Dec. 5 to 10, will be an outstanding event in the power plant field. Machinery, equipment and supplies developed to help power plants reach new standards of economy and efficiency will be exhibited there.

Many of these exhibits will represent the life work of leaders in invention, experimentation, construction, business organization and administration.

At the exhibits you will find many of the men who have created the equipment shown. Men who have gone into thousands of power plants to study the problems involved that they might make their equipment more useful in the successful operation of power plants.

Here at the New York Power Show the leaders in the planning, construction and operation of power plants will meet with the men who are responsible for the equipment and machinery they need.

Masters of power, these, with one common interest of making power more dependable and less costly. Work together they must, learn from each other they will, for the people will have power.

The Power Show at New York will be a great rallying point. Men will meet other men and there, too, they will meet the machines and working models of machines on which their common interest depends.

A program of talks, meetings and motion pictures will be given. Friendly intercourse will do its share to prepare for better exchange of ideas and for getting down to a mutual basis of business understanding.

In the field of power, where ideas are developing daily, where millions of dollars' worth of machinery, equipment and supplies are purchased monthly and where billions of dollars of invested capital must be paid its hire in yearly dividends, neither one show nor many shows and meetings can fulfill the demand for information and the interchange of ideas.

Hence the enlarged requirements of leading power plant men for the literature of their field, for the printed records of their meetings, shows and achievements that alone can preserve the essential ideas with dependable accuracy for immediate and future use.

The next issue of Power Plant Engineering is the first of the Seven Feature Numbers which were outlined in the last previous issue. It is the New York Power Show Directory Number, published Nov. 15. It will "open the doors" of the show to the minds of its readers three weeks in advance of the day when the actual doors are swung wide for your personal attendance.

Information on the exhibits—booth numbers, manufacturers' names and nature of exhibits—will be given in the editorial pages of the Nov. 15 Directory Number and manufacturers will present further information on their products in its advertising pages.

Use it as your guide to the show. Familiarize yourself with the latest equipment for the power plant and prepare to go directly to the exhibits of the equipment most important to your plant operation.

If unable to attend the Power Show, make this Directory Number and the succeeding December 1, New York Power Show Number, your means of keeping pace with its high points.

Machinery, Equipment and Supplies Used In The Production and Transmission of Power

Under the heading of each product listed will be found the names of the manufacturers of that product. The index to advertisers, next to the back cover, gives the page numbers on which the manufacturers' descriptive advertisements appear.

AIR COMPRESSORS.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Bethlehem Steel Co., Bethlehem, Pa.
Binks Spray Equip. Co., Chicago.
De Laval Steam Turbine Co., Trenton, N. J.
Gardner - Denver Co., The, Quincy, Ill.
Ingersoll-Rand Co., New York.
Murray Iron Works Co., Burlington, Iowa.
Worthington Pump & Machy. Corp., New York, N. Y.
Yeomans Bros. Co., Chicago.

AIR COOLERS
Spray Engrg. Co., Boston, Mass.

AIR FILTERS
Connor Co., Inc., The W. B., New York.
Spray Engrg. Co., Boston, Mass.

AIR HEATERS.
Prat-Daniel Corp., New York.

AIR PREHEATERS
Air Preheater Corp., The, N. Y.
Babcock & Wilcox Co., N. Y.
Combustion Engrg. Corp., N. Y.
Prat-Daniel Corp., New York.

AIR WASHERS.
Badger & Sons Co., E. B., Boston, Mass.
Buffalo Forge Co., Buffalo.
Connor Co., Inc., The W. B., New York.
Spray Engrg. Co., Boston, Mass.

ALARMS, HIGH AND LOW WATER.
Anderson Co., The V. D., Cleveland, Ohio.
Hills-McCanna Co., Chicago.
Huyette Co., Inc., The Paul B., Philadelphia, Pa.
Northern Equip. Co., Erie.
Reliance Gauge Column Co., Cleveland, Ohio.
Wright-Austin Co., Detroit.

ANTI-CORROSIVE COATINGS.
Dampney Co. of Am., Boston.

ARCHES, BOILER COMBUSTION.
Brady Conveyors Corp., Chicago.
Detrick Co., M. H., Chicago.
Girtanner Engrg. Corp., N. Y.
Harbison - Walker Refrac. Co., Pittsburgh, Pa.
Hofft Co., The M. A., Indianapolis, Ind.
McLeod & Henry Co., Troy, N.Y.
Obermayer Co., The S. Chicago.
Pilbrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Lock Haven, Pa.
Quigley Furnace Spec. Co., N. Y.

ASH BIN GATES AND DOORS.
Allen - Sherman - Hoff Co., The, Philadelphia, Pa.
Frederick Iron & Steel Co., Frederick, Md.
Girtanner Engrg. Corp., N. Y.

ASH HANDLING SYSTEMS.
Allen - Sherman - Hoff Co., The, Philadelphia, Pa.
Brady Conveyors Corp., Chicago.
Combustion Engrg. Corp., N. Y.
Detrick Co., M. H., Chicago.
Frederick Iron & Steel Co., Frederick, Md.
Girtanner Engrg. Corp., N. Y.
Link-Belt Co., Chicago, Ill.
Stephens - Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., The, Chicago.

ASH TANKS.
Brady Conveyors Corp., Chicago.

BABBITT METAL.
Magnolia Metal Co., New York.

BEARING METAL.
Magnolia Metal Co., New York.

BEARINGS, ROLLER.
Timken Roller Bearing Co., The, Canton, Ohio.

BELT CONVEYORS.
Stephens - Adamson Mfg. Co., Aurora, Ill.
Webster Mfg Co., The, Chicago.

BELT DRESSING.
Dixon Crucible Co., Jos., Jersey City, N. J.
Standard Oil Co. (Indiana), Chicago, Ill.
Stephenson Mfg. Co., Albany.

BELTING.
Crandall Pkg. Co., Palmyra, N.Y.
Goodyear Tire & Rubber Co., Inc., Akron O.
Quaker City Rubber Co., Phila.

BELTING, SILENT CHAIN.
Link-Belt Co., Chicago, Ill.

BLOWERS, FAN AND FURNACE.
Air Preheater Corp., The, N. Y.
Carling Turbine Blower Co., Worcester, Mass.
Coppus Engrg. Corp., Worcester.
De Laval Steam Turbine Co., Trenton, N. J.
Carling Turbine Blower Co., Worcester, Mass.
Ingersoll-Rand Co., New York.
Prat-Daniel Corp., New York.
Terry Steam Turbine Co., The, Hartford, Conn.
Wing Mfg. Co., L. J., N. Y.

BOILER FRONTS.
McLeod & Henry Co., Troy, N.Y.

BOILER MOUNTINGS.
Lunkenheimer Co., Cincinnati.

BOILER SETTING CEMENT.
Botfield Refractories Co., Phila.
General Refractories Co., Phila.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
Huyette Co., Inc., The Paul B., Philadelphia, Pa.
Insulating Products Corp., N. Y.
Obermayer Co., The S., Chicago.
Pilbrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Lock Haven, Pa.
Quigley Furnace Spec. Co., N. Y.

BOILER SETTINGS.
Botfield Refractories Co., Phila.
General Refractories Co., Phila.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
McLeod & Henry Co., Troy, N.Y.
Obermayer Co., The S., Chicago.
Pilbrico Jointless Firebrick Co., Chicago, Ill.
Queen's Run Refractories Co., Lock Haven, Pa.
Quigley Furnace Spec. Co., N. Y.

To Find the Manufacturers' Advertisements of Products Listed Here, See Index Page 162

BLOWERS, FORCED DRAFT.
McClave-Brooks Co., Scranton.
Sturtevant Co., B. F., Boston.

BLOWERS, PORTABLE.
Clements Mfg. Co., Chicago, Ill.
Sturtevant Co., B. F., Boston.

BLOWERS, PRESSURE.
Carling Turbine Blower Co., Worcester, Mass.

BLOWERS, PULVERIZED COAL.
Buffalo Forge Co., Buffalo.

BLOWERS, STEAM.
Schutte & Koerting Co., Phila.

BLOWERS, TUBE.
Diamond Power Spec. Corp., Detroit, Mich.
Marion Mach. Fdry. & Supply Co., Marion, Ind.
Sherwood Mfg. Co., Buffalo.
Vulcan Soot Cleaner Co., Du Bois, Pa.

BLOWERS, TURBINE.
Elliott Co., Jeannette, Pa.
Moore Steam Turbine Corp., Wellsville, N. Y.
Wing Mfg. Co., L. J., N. Y.

BOILER BAFFLES.
Boiler Engrg. Co., Newark, N. J.
Engineer Co., The, New York.
McLeod & Henry Co., Troy, N.Y.
Quigley Furnace Spec. Co., N.Y.

BOILER CAP CLEANERS.
Lagonda Mfg. Co., Springfield, O.

BOILER COATINGS.
Dampney Co. of Am., Boston.

BOILER COMPOUNDS.
Botfield Refractories Co., Phila.
Dearborn Chemical Co., Chicago.
Hawk-Eye Compound Co., Blue Island, Ill.
McLeod & Henry Co., Troy, N.Y.
Paige & Jones Chem. Co., Inc., New York.

BOILER COMPOUND FEEDERS.
Hills-McCanna Co., Chicago, Ill.

BOILER ENGINEERS.
Boiler Engrg. Co., Newark, N. J.

BOILER FEEDWATER PURIFYING APPARATUS.
Griscom-Russell Co., New York.
Paige & Jones Chem. Co., Inc., New York.
Permutit Co., The, New York.

BOILER TUBE CLEANERS.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh.
Roto Co., The, Hartford, Conn.
Sherwood Mfg. Co., Buffalo.

BOILER TUBES.
Babcock & Wilcox Tube Co., The, Beaver Falls, Pa.
Murray Iron Works Co., Burlington, Iowa.
Scully Steel & Iron Co., Chicago.

BOILER WALL COATINGS.
Botfield Refractories Co., Phila.
Insulating Products Corp., N. Y.

BOILERS.
Ames Iron Works, Oswego, N. Y.
Babcock & Wilcox Co., N. Y.
Badenhausen Corp., Cornwells Heights, Pa.
Casey-Hedges Co., The, Chattanooga, Tenn.
Combustion Engrg. Corp., N. Y.
Erie City Iron Wks., Erie, Pa.
Heine Boiler Co., St. Louis, Mo.
Kingsford Fdry. & Mach. Co., Oswego, N. Y.
Ladd Water Tube Boiler Co., Pittsburgh, Pa.
Murray Iron Works Co., Burlington, Iowa.
Springfield Boiler Co., Springfield, Ill.
Union Iron Works, Erie, Pa.
Vogt Mach. Co., Henry, Louisville, Ky.
Wickes Boiler Co., Saginaw, Mich.

BOILERS, HEATING.
Edge Moor Iron Co., Edge Moor, Del.

BOILERS, WASTE.
Edge Moor Iron Co., Edge Moor, Del.

BOILERS, WATER TUBE
Edge Moor Iron Co., Edge Moor, Del.

BOOKS & SCHOOLS.
Audel & Co., Theo., New York.
McGraw-Hill Book Co., Inc., New York.

BREECHINGS.
Connery & Co., Inc., Phila.
Heine Boiler Co., St. Louis, Mo.
Prat-Daniel Corp., New York.

BRUSHES, DYNAMO & MOTOR.
Dixon Crucible Co., Jos., Jersey City, N. J.

BRUSHES, GRAPHITE.
Dixon Crucible Co., Jos., Jersey City, N. J.

BRUSHES, WIRE.
Pilley Pkg. & Flue Brush Mfg. Co., St. Louis, Mo.

BUCKET ELEVATORS.
Brady Conveyors Corp., Chicago.
Link-Belt Co., Chicago, Ill.
Webster Mfg. Co., The, Chicago.

BUCKETS, CLAM SHELL.
Orton Crane & Shovel Co., Chicago.

BUCKETS, COAL HANDLING.
Orton Crane & Shovel Co., Chicago.

CARRIERS, PIVOTED BUCKET.
Webster Mfg. Co., Chicago.

CASTINGS.
Erie City Iron Works, Erie, Pa.
Fuller Lehigh Co., Fullerton, Pa.
Girtanner Engrg. Corp., N. Y.
Hills-McCanna Co., Chicago, Ill.
Neemes Fdry., Inc., Troy, N. Y.

CEMENT, FURNACE.
Botfield Refractories Co., Phila.
General Refractories Co., Phila.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
Insulating Products Corp., N. Y.
McLeod & Henry Co., Troy, N.Y.
Obermayer Co., The S., Chicago.
Pilbrico Jointless Firebrick Co., Chicago, Ill.
Quigley Furnace Spec. Co., N. Y.

CEMENT GUNS
Cement-Gun Co., Inc., Allentown, Pa.

CEMENT, HIGH TEMPERATURE.
Botfield Refractories Co., Phila.
General Refractories Co., Phila.
Harbison - Walker Refractories Co., Pittsburgh, Pa.
Brownell Co., The, Dayton, O.
Casey-Hedges Co., The, Chattanooga, Tenn.
Connelly Boiler Co., The D., Cleveland, O.
Edge Moor Iron Co., Edge Moor.
McLeod & Henry Co., Troy, N.Y.
Obermayer Co., The S., Chicago.
Pilbrico Jointless Firebrick Co., Chicago, Ill.
Quigley Furnace Spec. Co., N. Y.

CEMENT, IRON.
Smooth-On Mfg. Co., Jersey City, N. J.

CEMENT, INSULATING.
Insulating Products Corp., N. Y.

CHAIN WHEELS.
Babbitt Steam Spec. Co., New Bedford, Mass.

CHAINS, DRIVE.
Link-Belt Co., Chicago, Ill.

CHEMICALS, WATER TREATING.
Chicago Chemical Co., Chicago.
Permutit Co., New York, N. Y.

CHIMNEYS.
American Chimney Corp., New York, N. Y.
Prat-Daniel Corp., New York.
Springfield Boiler Co., Springfield, Ill.

CLEANERS, BOILER TUBE.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburgh.
Pierce Co., Wm. B., Buffalo.
Roto Co., The, Hartford, Conn.

CLEANING COMPOUND.
Dearborn Chem. Co., Chicago.

COAL AND ASH HANDLING MACHINERY.
Allen - Sherman - Hoff Co., The, Philadelphia, Pa.
Brady Conveyors Corp., Chicago.
Detrick Co., M. H., Chicago.
Frederick Iron & Steel Co., Frederick, Md.
Link-Belt Co., Chicago, Ill.
Orton Crane & Shovel Co., Chicago.
Stephens - Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., Chicago.

COAL BUNKERS, CAST IRON, CATENARY.
Allen - Sherman - Hoff Co., The, Philadelphia, Pa.